RAILROAD FREIGHT TRANSPORTATION

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DEDICATION

I venture to dedicate this work to the memory of A. J. Cassatt and E. H. Harriman.

Not only did these two men possess genius, a quality which Poe insists is far more abundant than is supposed; they possessed also the constructive ability, the faculty of analysis, the patience, the concentrativeness, that power of holding the attention steadily to the one purpose, self-dependence and the contempt for all opinion that is opinion and no more, and in special that energy and industry without which Poe insists the works of genius cannot be brought forth. As though this were not enough, they had, too, the leaven of a noble enthusiasm, which acted as a ferment, stimulating to their utmost effort all who enjoyed their confidence.

It was my fortune to be associated upon terms of intimacy with both these men, and to have rendered them some poor service. In a long activity, spread over wide areas, I have known many men: Presidents, governors, mayors of metropolitan cities; senators, congressmen, legislators; judges, lawyers, physicians of reputation; editors, educators, philanthropists; inventors, captains of industry, and railroad officers. If we search this illustrious company, there is nobody, not one, who can be said to put one in mind of these two, so like in their ability to achieve, so different in their personality and methods.

THE PURPOSE OF THIS BOOK

The United States, in its large and compact territory, possesses more than half the world's sources of power—coal, oil, and hydraulic—and more than half the sources of the great basic minerals—iron, copper, lead, and zinc. It dominates the world's markets with the great staple commodities—cotton, wheat, and meats. Its people are of high character, intelligent, of good morals, sturdy physique, and great acquired skill, with a willingness to work, an eagerness to maintain a high standard of living and to acquire wealth.

The rapid growth of the population, the great areas over which it is spread, and the character of its activities have led to a great development of freight transportation upon steam railroads. This development has in turn made possible a growth of industry and commerce not even remotely approached in any other country.

All of the functions of a railroad arise from and focus in transportation. As they have become highly specialized, the functions of each department have found exposition in many books. But no book has been written immediately concerned with transportation, the reason for the existence of the railroads. It is the purpose of this book to assemble in reasoned order all of the phases of loading, distribution of cars, movement of engines and trains, handling of men, the features of permanent way and shop plant, the organization through which they are controlled, and the accounting made of their activities—as they are related to transportation. It is concerned with all that enters into freight transportation. Only to the extent that phases of other activities of the railroads are immediately related thereto is reference made to them.

LEONOR FRESNEL LOREE

"BOWOOD," WEST ORANGE, N. J.

April 23, 1922

The field of knowledge hath been so traced, it is hard to spring anything new; but to reveal, to testify, to point out the path which we have followed, to endeavor to convey to others some faint sense or suggestion of what we have found, must have petted even the hearts of the men who dwelt in caves.—ANON.

FOREWORD

In July, 1920, I was forced to keep my bed for some three weeks with injunctions not to raise my head from the pillow. I had ample time for reflection. The railroads had come back to their owners from the hands of the Federal Government after the terrible smash-up of its experiment in operation. They had come back much deteriorated in permanent way. The diversion to the military necessities of the Government, in the first ten months of its operation, of metal and timber needed in maintenance had not only not been made good during the sixteen months of the retention after the Armistice, but the depletion had continued. They had come back with both the power and the car equipment in bad condition, because of the postponement of necessary repairs in an effort to retrieve, by unduly reducing expenses, the great deficits accruing because of the failure to increase rates in the spring of 1919. The freight cars, which had been scattered broadly over the entire country, were conspicuously in bad condition. The railroads had come back, but they had come back with labor greatly lowered in efficiency through the introduction of many new and untrained men, through changes in rates of pay that had destroyed the long-established differentials, and because of active propaganda to organize all of the men into labor unions. Discipline was impaired and the authority and morale of the officers severely shaken. The Government had purchased with lavish bribes a precarious place with labor. With the high cost of living and the low state of production, there was rapidly coming on a conflict between the minority constituting organized labor and the unorganized social majority for the real control of the Government.

The conditions from one point of view had been summed up by the *Journal of the Brotherhood of Locomotive Engi-*

neers in an editorial in its issue of May, 1920, under the caption "Lost their Grip":

> Now that the railroads are back under private control, there will be an effort to restore the old-time pep-and-get-there which existed in the ranks before the war. But there's nothing to it, for as sure as you are living, the railroads have lost their grip on their employees. To now tighten up the reins of authority that have lain loosely across the dashboard for the past two years will not bring the desired results. . . . Yes, it is a safe bet that we have witnessed the passing of the once numerous type of railroad men who took pride in their work and considered no sacrifice of risk or effort too great to get results for the Company. These same men to-day are content merely trying to hold their jobs. The old interest and the old pep are things of the past, for the railroad officers have surely lost their grip.

Never was the sale of the live bear's skin undertaken with greater folly and assurance. The remedy was to be sought by raising in the men their self-respect and making their duty a thing of pride in them; by stimulating the officers to individual initiative, a quickened sense of individual responsibility, and an aroused energy, perhaps the noblest feeling of humanity.

I found myself recalling a conversation many years ago with the author of a proposed history of one of our great railroads, as, for two hot, sweltering days, we turned his manuscript over, page after page. When we reached the last, he challenged me for my opinion, which he said should be entirely frank. "The book is," I told him, "the story of Hamlet with Hamlet left out. You have written the history of a great transportation company and have said nothing of transportation. The inception of the enterprise, the men who promoted it, the raising of money, the location and construction, the provision of equipment, the standards of maintenance, the soliciting of business, the accounting for multitudinous transactions, the handling of funds, the growth, development and progress in all these aspects with the expansion of the enterprise in this half-century—all these are here in illustrative detail and orderly arrangement; but of transportation, the reason for the existence of the enterprise, the

purpose of its being, the circulation of its vitalizing energy—not a word." This was not a fault peculiar to this author; it is a fault common among railroad men. For one thought they give to transportation, and especially to its outstanding problems—the moving of trains of various speeds upon the same track and the assembling of cars in such order as to assure their farthest movement without re-handling and their distribution with the least interference, they give a thousand anxious and curious glances in as many other directions.

Master of Transportation! Once a significant but now an obsolete title, how many are there in the service to-day competent to bear it? Yet until we have Masters of Transportation and a goodly number of them; until their voices are not only heard but heeded; until, in short, transportation again comes into its own, we shall fall far short of making our railroads what they have been and may be again—chief among the servants of our industrial civilization.

There is another factor even more seriously neglected. During the last generation how little thought has been given to the management of men! Of late, when a dispute has been adjudicated, after more or less friction, the whole matter has been dismissed with the petulant hope that it would not soon again become troublesome. The neglect of this important problem I pointed out at a dinner of the American Railway Engineering Association in Chicago on March 20, 1912:

Your Association has now been in existence for nearly twelve years, and has published nearly 9000 pages of proceedings. It is interesting to note that your activities have been directed in the following proportions:

On the problems of Roadway	12	per cent
" " " " Track	30	"
" " " " Major Structures	28	"
" " " " Minor Structures	15	"
" " " " Miscellaneous	15	"
	100	"

If we reflect that the total Maintenance of Way expenses of the roads of the country are about $300,000,000 annually, and that of these expenses the moneys paid out for labor amount to 56 per

cent, while all the other expenses amount to but 44 per cent, it would seem to justify the suggestion that your Association devote at least a substantial part of your work to the study of labor. I would, therefore, urge that to the present list of regular committees there be added a Committee of Maintenance of Way Labor, whose duties shall be to investigate the conditions of employment of and the relation of Maintenance of Way labor to seasonal supply and demand; to consider questions of economic organization, education, discipline and equipment of forces for various kinds of work, and such other questions as shall from time to time be assigned by the usual authority.

With brilliant and isolated exceptions, in spite of the continual challenge of recent events, little sustained attention has even yet been given to these two central problems—transportation and the men engaged in transportation. It is these two matters that must engage the conscientious, intelligent thought of the railroad officer if the service is to be made what it should be.

Few seem to have any conception of the disproportionate burden that has been thrown upon the transportation industry; of the fact that to-day, as compared with thirty years ago, the increase in its effort necessary to enable our industrial civilization to function must be seven times the increase in the effort made by the producer. The producer in mining, lumbering, agriculture, or in manufacture, produces quantity which can be determined in terms of weight. The transporter produces ton-mileage, which is the product of weight and distance. A study of Figure I, prepared by the Federal Reserve Bank for the District of New York, shows:

1. The average annual increase through the last 30 years, from 1890, was about 3.2 per cent for quantity production of commodities, etc., and about 6.2 per cent for the ton-mileage. This means that the ton-miles increased each year about twice as fast as the quantity production.

2. As the rate of increase is double each year and is compounding year after year, the effect has been that the total ton-miles from 1882 to 1920 have increased over seven times as much as the total quantity production for the same period.

Nor is there appreciation of the manner in which the traffic is divided among the railroads and the problems to

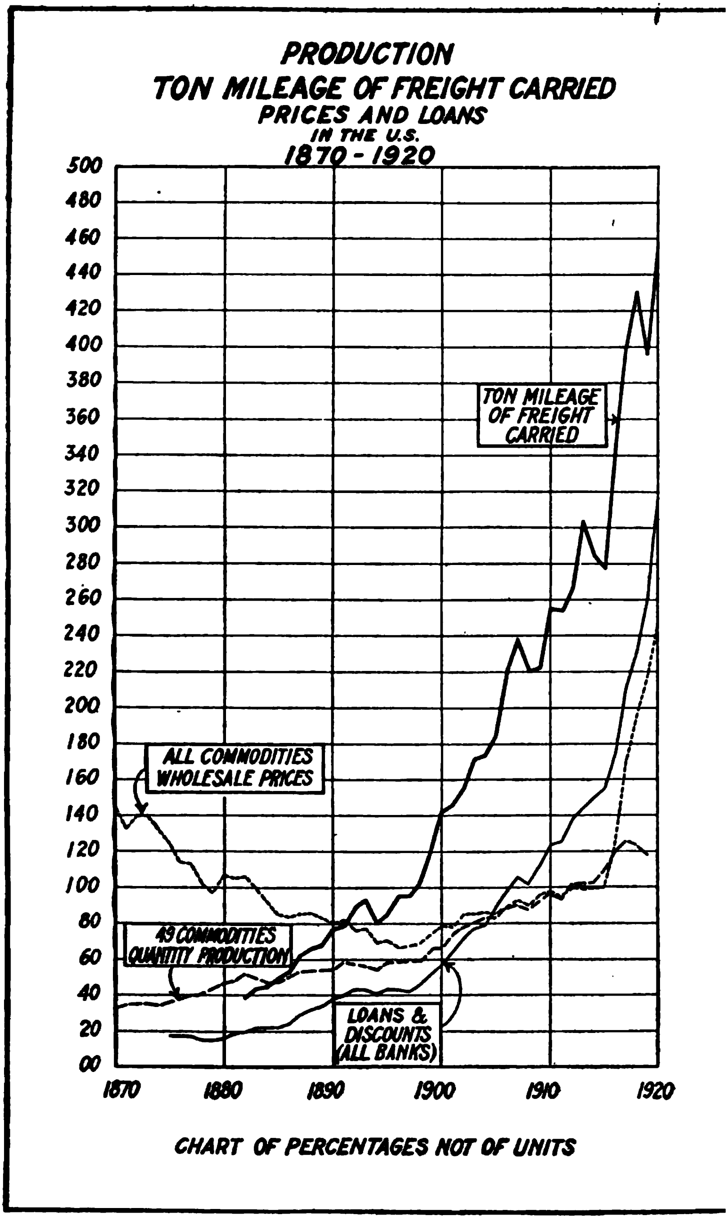

FIG. 1.—COMMODITY PRDUCTION AND PRICES; TON MILEAGE; LOANS AND DISCOUNTS.

which this gives rise. The railroads of the country embrace 253,708 miles. It seems probable that 28,708 miles should be abandoned as no longer economically justified. Half the traffic is concentrated on about 25,000 miles of railroad, or less than 10 per cent of the whole. The companies operating the remainder have to get along as best they can on such profits as may be derived from handling the other half of the traffic, and this with wide variations in climatic conditions, physical geography, and in the grades necessitated by the topography of the country served.

In our country, as Blanchard has pointed out, the complexities and difficulties of railroad administration are greater than in any other because of its greater area, larger railroad mileage, longer coast lines, the great navigable lakes, diversities of soil, climate and products, differences between lines of high mountain gradients and those nearly level, the rapidity of traffic development, the desire to grasp foreign markets, differences in railroad charters and dissimilarities of legislation, the anomalous and conflicting state and national authority within and across boundaries purely political, and the proximities of foreign governments.

The United States, in its large but compact territory, is singularly blessed with vast and varied resources. It has an excellent climate and an extraordinarily fertile soil. With more than half the world's resources of power—coal, oil, and hydraulic, it has more than half the resources of the great basic minerals—iron, copper, lead, zinc. It dominates the world's markets with these raw materials and with great staple commodities such as cotton, wheat, and the meats by means of a most precious resource—not a dead product but a living and vitalizing agency—men, and men of high character, intelligent, of good morals, sturdy physique and great acquired skill, with a willingness to work and eagerness to attain a high standard of living and to acquire wealth. The rapid growth of the population, the great areas over which it is spread, and the character of its activities have led to a great development of freight transportation upon steam railroads. This development has, in turn, made pos-

sible the growth of industry and commerce not even remotely approached in any other country.

Herein lie both challenge and joy for transportation officers and transportation men.

Somewhere there should be found assembled in reasoned order all those phases of loading, distribution and movement of cars, engines and trains, and handling of men; the features of the permanent way and shop plant; the organization through which they are controlled; and the accounting made of their activities with which the transportation officer and the transportation employee should be familiar. No such work now exists.

Here, then, were the problems, large and fundamental, that cried out for attention. I therefore sat down, when my period of enforced meditation was at an end, to the preparation of a series of memoranda on freight transportation, pointing out some of the things that help and some that hinder the prompt and regular movement, and this in spite of a full recognition that there is a universality of duty and interest running through the whole railroad world which makes it very difficult to deal with one part of that world only. These were submitted, from month to month, to the officers of the companies of which I had charge, for discussion and consideration with reference to their own situation and practice. The methodical study of problems thus presented served to focus thought and activity upon current duties with the happiest results.

Prepared originally for the officers of my own companies, I venture to offer this material, expanded and rearranged, to the whole body of railroad officers in the hope that it may be helpful to them.

The railroad is a common carrier. While all of its functions arise from and focus in transportation, they have become so highly specialized that each department finds exposition in many books. This book is concerned with all that enters into railroad freight transportation. Only as phases of construction, maintenance, organization and activity are immediately related thereto is reference made to them.

As it is addressed to "officers" and as they are familiar with railroad practices, I have omitted definitions with which they are familiar.

In the introduction to his "Roman History" Rollins said, "I have not concealed the fact that I have made much use of other men's labors. My work is made up of other men's labors and if my readers find it interesting, I will beg them to consult the bibliographies, all too scanty, placed at the end, and in justice to ascribe any merit of this book to the excellent collaborators named therein." Instead, therefore, of encumbering these pages with wearisome references too hard to get at, or to forgotten works and scattered records, acknowledgment is here expressed to the authors to whom reference is made, whose works I have consulted with equal profit and pleasure, and can heartily recommend to others. If I seem to have appropriated the ideas of others or used their expressions without quotation marks, I here make my apologies. Acknowledgment is also expressed to my Secretary, F. W. Leamy, to C. E. Johnston, General Manager of The Kansas City Southern Railway Company, and to J. T. Loree, General Manager of The Delaware and Hudson Company.

I can make no pretense to having the gift, possessed by few, of locking in happy phrase a difficult and complex thought. What I have tried to do is to group all the more important facts in logical order, not to write a book but to deliver a message. If any lay down the book disappointed with its inadequacy, I can only plead that the subject is vast both in detail and dimension. I have done not what I had hoped, but what I could. I heartily wish that my effort may stimulate someone to do it better.

L. F. L.

Amurath to Amurath descendeth,
But the stars in their courses rise
And the strong towers that we have built,
They endure.—PERSIAN POET.

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RAILROAD FREIGHT TRANSPORTATION

PART I

THE PERMANENT WAY

PART I

THE PERMANENT WAY

In his daily intercourse with his fellow officers, the transportation man will feel surprised, upon reflection, to realize how seldom he will need to consult with those of the Maintenance of Way Department, and how constantly he will need to be in touch with those of the Maintenance of Equipment Department. He is entitled to be furnished by his colleague of the Maintenance of Way Department with proper track and terminals, with all their accessories and appurtenances. He will find in the "permanent way" certain helps and hindrances to his conduct of transportation. These I proceed to set forth.

1. Drainage.—Engineers insist that the first and last requisite for the maintenance of a good and sound track is a perfect system of drainage. Recurrent trouble through bad surface in a particular section of track is likely to be due to defective drainage. Drainage is not generally given the place it deserves in the proper maintenance of track; where it is provided, not only is the track maintained in better surface, but at a material saving in expense. It is a matter in which our practice falls far short of European standards.

2. Ballast.—The purpose of ballast is to afford a sufficient base for the support of the rolling load, to carry off the rain water, to afford a means of keeping the ties to their grade line, and to give elasticity to the bed upon which the track structure rests. Generally our railroads fail in the application of this important material. Ballast is the foundation for the track, that is, for the assembled structure of ties, rails, and fastenings. The same conditions are ap-

plicable to it as to any foundation work. Some structures require foundations only a few feet in depth, while others require foundations many feet in depth, or must be supported on piles, mattresses, slabs, or by other expensive methods.

The amount of ballast to be applied in order to produce a permanent ballast section depends entirely upon the character of the sub-grade; six inches may suffice on rock or indurated soil, many feet may be required in yielding soils. To distribute the rolling load so that each tie shall support its full burden ordinarily requires not less than 12 inches between the bottom of the tie and the top of the sub-grade.

3. Track Surface.—One of the offenses of the track foreman, still prevalent, is to bring one rail to the grade line set for it and then, discarding the track level, to attempt to bring the other rail into the same horizontal plane by "sighting across." Not one man in a hundred can do this successfully. The result is a waving track, rolling the cars as they pass over it, with the motion much magnified at the running board 12 to 14 feet above the rail, much to the discomfort and sometimes to the danger of the brakeman, not to speak of the effect on the load or on the structure of the car body, particularly its roof.

The almost universal use of staggered joints, replacing the old practice of opposite joints, while enabling the track to be maintained in better surface, is a positive detriment when the surface is allowed to deteriorate, accentuating as it does the rolling motion of the cars.

4. Lumpy Track.—It is a frequent experience to see track foremen raising track with a "sighting board." Track should never be raised except to grade stakes set to insure a uniform plane of grade. The result of a makeshift practice is lumpy track, the effect of which, in increasing the energy necessary to move the train, may be considerable.

The plane of the grade is likely to be further distorted by subsidence in fills and by the raising of the track in cuts where the drainage is inadequate.

We are slow to recognize the effect of these distortions.

I recently had a piece of track restored to its original grade after a period of neglect and abuse, and the dynamometer tests before and after showed there had been a loss of 10 per cent in loading.

5. Pitches and Sags.—Frequently bad conditions are inherited from the construction period. Such are pitches and dips or sags in passing from one rate of grade to another, and especially the double sags frequently encountered in passing over bottoms not overwide with a stream in the center. These are the frequent causes of "break-in-twos." They may be remedied in the case of double sags by lifting out one or both, and where due to carrying the grade lines to an intersection, by the application of a vertical curve. I recall one division which had in a year 117 "break-in-twos." While some might have been attributed to careless handling, they were for the large part due to pitches, sags, or double sags. In four or five years, by patiently working out these faults in the track and by some stiffening of discipline, we entirely eliminated this serious trouble.

6. Tunnels.—Tunnels are sometimes the cause of much difficulty in the movement. Where grades meet in a tunnel gases tend to collect at the summit. Relief is frequently had by a shaft, which it may be desirable to equip with a fan to maintain the circulation. Where prevailing winds prevent the normal escape of the smoke, doors may be used to advantage, and they are also a protection where water is troublesome and forms ice in cold weather. Tunnels are not apt to be serious sources of trouble where they are not longer than 3,000 feet, but they are always an obstruction that must be reckoned with.

The English have dealt with this matter much more courageously and successfully than we have. The double-track tunnel of the Great Western Railway, under the Severn River at Bristol, was opened for traffic in 1886. In those days about 50 trains passed through in twenty-four hours, and the ventilation was effected by a fan 40 feet in diameter, 12 feet wide, acting as an exhauster, drawing air from a shaft about 1½ miles from one end. The total length of

this tunnel is 4.35 miles; the cross section 26 feet wide by 20 feet high; the gradient on the east side 1 in 100 and on the west side 1 in 90. Trouble is now appearing with the ventilation, the traffic having increased to 150 trains each twenty-four hours, and consideration is being given to the installation of a much more powerful ventilating plant, a much cheaper method than the alternative of electrifying the railway.

7. Snow-fences.—Snow is moved by the wind close to the surface of the ground, and is deposited in railroad cuts by the eddies which they cause in the wind currents. Snow-fences are erected to create eddies on the windward side of cuts and at sufficient distances to cause the deposit of the snow between them and the fence. The character of the fence and its location depend upon local conditions, for the determination of which some experimental trials are generally necessary.

Lecount says that:

> Many doubts were entertained, at an early period of the railway system, as to the performance of engines when snow lay on the rails to a depth which on the common roads interrupted the ordinary communications of the country; they have, however, completely triumphed over this difficulty; a striking proof of which took place on the Newcastle and Carlisle Railway; where the possibility of working the engines, under the above unfavourable circumstances, was put to the test on December 20, 1836, in the deep cutting through the Cowran hills, where the snow had accumulated to the depth of four or five feet, when the Hercules engine came down on the morning of the above day. Numbers of the country people assembled to see how it would act in such an emergency, and to render any assistance which might be necessary. On arriving on the spot, however, the engine dashed right into the drift, clearing its way through, apparently without any difficulty; the snow at the same time flying over the top of the engine chimney, like foam from the broken waves of a violent sea; and notwithstanding this and other similar obstructions, the trains came down from Greenhead, twenty miles, in one hour and a quarter, and their times of arrival were properly kept up, whilst all the communications by the ordinary roads were more or less seriously obstructed, if not entirely cut off.

8. Snowplow Markers.—Snowplow markers are set up on either side of the track in advance of private road crossings

or any obstructions that would interfere with the operation of the flangers, and the situation should be checked over in the late fall to see that they are in their proper places. It is illustrative of the modernness of much of our practice that I designed a marker, the black triangle with yellow spot, still very generally used in the eastern section of the country.

9. Switches.—The switches should be safe and easy to operate and placed where possible on straight track; they and the frogs blocked with foot guards to prevent accident; both kept clear of snow and ice during winter-time, and their surroundings free from obstructions and litter over which trainmen or switchmen might stumble or fall. The practice of clearing snow by fires is often followed by the freezing of the melted snow, resulting in a condition even worse than that sought to be removed. Hydrocarbon, a by-product of Pintsch gas, can be used to advantage, as the snow and snow-water disappear in the combustion.

The following table shows relative speeds through level turnouts to give equivalent riding conditions to track elevated 3 inches less than required by the degree of curvature:

RELATIVE SPEEDS THROUGH LEVEL TURNOUTS

Turnout		Speed
Frog Number	Length of Switch	Miles per Hour
4	11	9
5	11	12
6	11	13
7	16.5	17
8–10	16.5	20
11–14	22	27
15	33	37
16–24	33	40

10. Switch Protection.—In approaching a siding it is necessary for the head brakeman to run ahead of the engine to open the switch, and on leaving a siding the flagman, after closing the switch, must run after and overtake the caboose. The roadbed on the side of the track on which is

the switchstand should be widened out and brought to a level but little below the bottom of the ties to provide a suitable runway. If the switch happens to be near a bridge, a runway should be laid down on the bridge ties or hung on the outside of the bridge. These runways should be from one hundred and fifty to two hundred feet in length.

Low voltage machines for the actuation of switch points at sidings are now coming into use, and consideration should be given to their advantages.

11. Curve Elevation.—The train in passing into a circular curve from the tangent is frequently subjected to a sharp lurch. The requirement of the tangent track that both rails be in the same horizontal plane, and of the circular curve track that the outer rail be so elevated that the centrifugal force will be fully compensated, the weight on both rails be the same, and the train run as steadily as on straight track, cannot be complied with at the point of the circular curve. The transition curve [1] furnished a method of suiting the elevation of the outer rail to the rate of curvature and should be applied to the ends and compound points where the circular curve is 1 degree or over. The result is the smooth riding of the train, and the tendency of the track to shift at the ends of circular curves is much reduced, if not

[1] Gravatt about 1828 suggested an easement of sines and Fronde about 1842 a curve approximating the modern easement. Both were published by Rankine in 1861. On the location of the Steubenville and Indiana Railroad (now part of the Pittsburgh Division of the Pennsylvania Lines West), made by Mr. Jacob Blickensderfer, Chief Engineer, in 1850, all curves of two degrees and over were located with easements, consisting of a series of compound circular curves. There were doubtless other methods resorted to by the engineers of those days. The alignment of the Pittsburgh Division between Pittsburgh and Steubenville was rerun by Elliot Holbrook in 1880 and transition curves of hyperbolic spirals used. I spent the evenings of the winter of 1887 preparing a pamphlet of six different cubic hyperbola easements, with illustrations and tables for their application to the various problems normally presented, and this practice was made standard for the Pennsylvania lines. The entire subject was further developed and published in *The Transition Curve* by C. L. Crandall in 1893. The same spiral was used by Professor A. M. Talbot in his publications in 1891 and 1904. While there is but little difference between the curves of the cubic hyperbola and of the cubic parabola used as easements, the fact that the former is applied with the transit and the latter by offsets has always made the former seem the more workmanlike job.

wholly overcome. The experience is that it takes about 10 per cent more time to run in the transition curves. In 1895 the *Railroad Gazette* reported that they had been applied to about 25 per cent of the mileage of the country, and a study recently completed by the *Railway Age* indicates that the use of transition curves is now almost universal for main line railroads. The elevation to be applied to curves demands consideration of location, grade, speed, and character of traffic. On lines of high-class passenger traffic the elevation must conform to the high-speed trains and the lower rail receives the greater load and wear. Local conditions, such as proximity to station or railroad crossing, affect the speed of trains and are factors in determining elevation. The elevation of the outer rail should not exceed 8 inches. At this elevation trains can run 60 miles per hour on a 6-degree curve without bad results. In the old days we used to hear stories of curves set up with excessive elevation upon which, when a train was brought to a stop, some of the cars were overturned. I have no doubt that many of these stories are true; I myself once knew of such a case.

12. Curve Resistance.—While the train is moving upon curved track, lateral motion due to obliquity of traction, centrifugence, and the action of the wheel upon the rail cannot be entirely overcome. This resistance is a function of the central angle, not of the degree of curvature, and is usually taken per degree as the equivalent of grades of 0.035 per cent to 0.04 per cent. There was for a long period a failure on the part of locating engineers to give effect to this cause of resistance, and on such roads the tonnage rating indicated by the rate of grade not only cannot be secured but it is often substantially reduced.

In order to reduce still further the resistance of curves, devices are used on the locomotives for spreading oil on the inside of the rails, which have given excellent results. Promising results have also been obtained from the development of constant-resistance lateral-motion devices on driving wheels to meet the extended rigid wheelbase conditions.

13. Gauge Widening.—The obliquity of traction of the trucks will set up noticeable resistance where the train is pulling through the sharper curves, and the practice is to widen the gauge to give the necessary relief. The usual practice is to make the gauge, in the case of curves of 4 degrees and over, 4 feet 9 inches, and to widen the gauge to 4 feet 9 inches on heavy grades against the traffic, on tracks used exclusively for freight trains, and through switch leads.

14. Rail Creeping.—This is a very serious matter, difficult to overcome, expensive and hazardous to operation. Attention should be given to the ballast, spacing and condition of the cross-ties, the weight of rail, condition of the joints, expansion, and curve elevation, but even more to the character of the roadbed and especially to the drainage. Many styles of rail-anchors and anti-creepers are in use and in many cases offer an adequate solution of the difficulty.

15. Track Kinks.—Deformation of the alignment is frequently the result of changes of track in order to run round station platforms, water standpipes, slips in side hills, cuttings, etc. Unless care is taken by the engineers to have these "kinks" carefully handled by proper curvature, considerable resistance to train movement may result. I recently saw the dynamometer measure of the tractive effort of moving a train through two such kinks 600 feet apart, one swinging out from the original alignment 3¼ feet, the other 4¼ feet; the engine that had been moving the train comfortably was compelled to increase its tractive effort 3000 pounds. Such deformations may oppose serious difficulties to starting a train, and unfortunately are most apt to occur where trains are frequently stopped.

If now the transportation officer has a track in proper surface, alignment, gauge and curve compensation, free from creeping, resting upon a minimum of ten inches of a ballast that will readily dispose of storm water and melting snow, upon a roadbed properly drained, free from "soft spots" and of sufficient width to support the track, then his

wants in this regard have been satisfied. But all these things he is entitled to have and, lacking them, he should clamor for them. He may fail in this endeavor, but things are never unutterably bad; there will always remain to him the philosophy of the old woman, who, having only two teeth, thanked God that they met.

16. Grades.—It used to be said, when I was a youngster, that no road with grades not exceeding 0.5 per cent ever went into the hands of a receiver. I do not know whether or not this was literally true, but certainly the transportation and cost advantages of a superior grade line give its possessor a commanding advantage over a less fortunate competitor. The engineers who were in the railroad service before the Civil War were a well-educated and resourceful lot of men who thoroughly understood the problems involved in their work, and, considering the tools, materials, and capital at their disposal, produced for their time a very superior transportation instrument, working out and installing many of the appliances and practices we still use. After the Civil War, and especially in the years of great speculative activity, the opportunities for developing the country through profitable railroad construction led to much hasty work, directed rather to the penetration of new territory or the protection of a traffic region than to "economic location," with a view to future operation. This condition did not begin to improve until after the appearance of Wellington's monumental work on *Economics of Railway Location* in 1887. Not uncommonly a railroad president, learning that a rival corporation was looking over territory that he had marked for his own line, or even fearing that he might do so, hurried to New York, and, after arranging with the road's bankers for the sale of bonds to provide the necessary construction funds, would telegraph his chief engineer to let contracts on the prevailing unit basis and begin at once the construction of the new line. Coincident with the arrival of the engineering parties and the right-of-way agent, was that of the contractors with their outfits demanding grade stakes that they might begin work at once, lest their profits

be eaten up by delay. Restricted only by some general rules, such as that the maximum grades must not exceed one per cent nor the maximum curvature six degrees, the engineers threw their lines across the country, resorting to the maximums freely when delay could be avoided thereby. Careful reconnaissance and painstaking fitting of the line to the contours was impossible; the whole job was a wild scramble and the result a handicap to be carried for many years by the owners and their transportation officers. It is possible to follow miles of this type of location and realize that where one per cent grades were adopted, grades of 0.5 to 0.3 per cent, within four or five miles on either side, were possible. I recall a line located with a one per cent grade but the construction of which was fortunately held up. The maps clearly indicated a much more satisfactory location. A relocation, upon which the line was subsequently built, gave a three-tenths line several miles shorter and several hundred thousand dollars cheaper.

There were cases where dense forest growth, great arid tracts, or other conditions furnished a better excuse, and always there must be considered the limitations of the then existing knowledge, the necessary restrictions imposed upon the engineer by the then sum of technical resources, materials and designs, and available capital. For much bad location, however, there is little explanation save the universal wastefulness of a period of primary development.

On the other hand, notwithstanding careful engineering, the locations of roads built prior to the Civil War are often ill-adapted to the volume and character of the traffic now being handled. The business of that day was so thin that one marvels at the courage of the undertakings. For example, the promoters of the Albany and Susquehanna Railroad Company, 141 miles long, built over the foothills of the Helderberg range, looked forward to annual gross earnings of $715,000. Necessarily the promoters had to meet the wishes of prospective patrons and often the route was diverted to pass through a village for the prevailing considerations of traffic. Nor were the resources such as to

warrant heavy expenditures to secure better alignment and grades later justified by the growth of the business.

A great deal has been done to correct these initial disadvantages, perhaps more by the Pennsylvania Railroad than by other lines. Its Chief Engineer, William H. Brown, told me in 1901 that of the 104 miles of line between Philadelphia and Harrisburg all but four miles had been changed from the original location. In going over the line in 1921, its Operating Vice President, General Atterbury, told me that of the original line between those two points there remained but one piece on its original location, the track over the bridge at Coatesville.

While much has been done, much more remains to be done in correcting these initial handicaps and errors. Meanwhile, towns have grown up, the country has been brought under cultivation, and both the difficulties and the cost of rectification have greatly increased. It is surprising, however, how much can sometimes be accomplished at small expense. I was at one time operating a division 117 miles long with maximum grades of 1 per cent, which we reduced in two years to 0.3 per cent at a cost of only $80,635. Quite recently I brought down the grades in the direction of the heavy traffic on a division 122 miles long from 1.35 per cent to 0.80 per cent at a cost of $372,987. When I was a general manager I was very much interested in work of this character, and although I started and accomplished a certain amount, I have always looked back with disappointment at my failure to accomplish much more. I had, immediately on taking hold, called the interested officers together and directed an investigation of the limitations of clearances, bridge loading, curvature resistance, rail conditions, etc., with a view to designing the heaviest freight locomotive of the consolidation type that conditions permitted operating. From the Civil War until 1884 we had used a consolidation, weighing 30,300 lbs. on the drivers, having cylinders 16″ × 24″ and developing 10,520 lbs. tractive effort. In 1884 Altoona had designed a consolidation weighing 111,500 lbs. on the drivers, having cylinders 20″ × 24″ and develop-

ing 22,870 lbs. tractive effort, and these two types constituted all our freight power. So in 1896 we moved up to the last of our limitations and brought out a consolidation weighing 161,000 lbs. on the drivers, having cylinders 22″ × 28″ and developing 42,160 lbs. tractive effort.[1]

Having exhausted, for the time being, this method of increasing train load, I was pressing in all directions for grade reduction and lamenting my failure to interest my superiors. The President was coming out on an annual inspection and I assembled on a track, where he would be faced with them upon alighting, the oldest and the newest of our locomotives, and set up between them a sign reading, "The little engine is the standard of 1869. The big engine is the standard of 1897. The little engine can bring from Pittsburgh to Wellsville a larger train than the big engine can bring from Wellsville to Cleveland." (See Figure 2.) There were many wry faces in the party at what they must have considered an ill-timed jest, but no lightning struck me. I suppose much is forgiven youth and audacity. However, as a means of stimulating practical interest in grade reduction, the exhibit was a total failure. This whole question of moving men, whether or not you have authority over them, will bear a lot of thought. Apparently, little is gained by argument but much is to be hoped for by keeping the facts constantly in evidence. As to moving the mass of men, Lord Fisher says, "they cannot be moved by brains but only by emotion and earnestness."

In the original location and construction of some of our older railroads, especially in the West, real estate and town site conditions were given consideration over operating conditions; in result, depots, sidings, water and coaling stations were often placed on ruling grades. These conditions are the cause of much overtime and many delays and break-in-twos of trains. Much care should be taken to avoid such

[1] I have always believed in the practice of building little at a time, building often and making every possible endeavor each time to improve as much as possible on the last preceding effort. As a comparison with the earlier days, it may be interesting to give here corresponding figures of the last consolidation I have had built: Weight on drivers 267,800 lbs., cylinders 27″×32″, developing 67,150 lbs. tractive effort.

FIG. 2.—LOCOMOTIVES OF 1869 AND 1897 PENNSYLVANIA LINES, WEST.

mistakes. It is an operating axiom that all planned stops should be on a level or on a slack grade sufficiently less than the ruling grade to permit starting trains without undue effort or delay, and without reducing the full engine rating. The slack grade should be about three train lengths long.

When grade changes are to be made and track continued in operation, much care should be taken to prevent interfering unduly with train movement. The best mechanical devices should be used, a long-armed steam shovel and automatic dump cars or flat cars with side guide plows and Lidgerwood unloader. When temporary tracks are used they should be of substantial character. Interference with the main track should be reduced to the minimum, and the track should be raised rather than lowered. In making changes of grade on double track, time will be saved by putting one track out of commission, and operating the other track as single-line track with telegraph operators at each end.

I would like to dwell upon the importance of low grades, not alone in reducing transportation costs but in consolidating the traffic in fewer trains, adding much to the capacity of the road. Since the effect of the grades upon engine rating varies directly as the rate of grade, the results achieved by reductions are easily visualized.

Changes not only in grade but all changes, improvements, and additions should be based upon and brought to the test of actual money value. Their cost should be measured against the capitalized value of the savings to be effected.

17. Layout for Helper Engine Service or Doubling-the-Hill.—As Wellington points out, it is of the first importance to observe that the objection to high gradients is not the work the locomotives have to do on them (the maximum summit, however it may be approached, has finally to be surmounted), but rather the work that these locomotives do not do, when they thunder over the line with a light train behind them from end to end of a division, in order that power may be on hand at a few scattered points where alone it is needed. But where economy in operation is effected by working the locomotive to its capacity over the entire divi-

sion, and the controlling adverse grades are overcome at one or more points either by supplying helper locomotives or by doubling-the-hill, these points, in their turn, should not be permitted to become spots of hindrance. The lay-outs should be properly designed and amply equipped, in the one case with relief track where warranted, and set-off and run-around tracks; and in the other with refuge tracks, coaling and water facilities, and telegraph or telephone facilities.

Where the grade is located within ten or fifteen miles of a terminal, overloads may often be set off to advantage at the foot of the grade and brought in in drags by a yard engine.

The relative cheapness of doubling-the-hill warrants its careful consideration. Resort may be had to it where the cost of helper service is prohibitive and doubtless there are cases where it could be substituted with economy. As against this, delay to the movement must be taken into account. But, everything considered, it seems that doubling-the-hill is a resource that has not been fully appreciated.

The following is suggested as one way of approaching the problem:

Assuming one adverse grade; track facilities alike in either case; the same consumption of fuel and supplies and equal repairs; actual running time 10 miles per hour and one-half hour delay to helper each round trip; the crew doubling and receiving standard rates per mile for additional mileage; the cost of a helper engine for one day of eight hours taken at $25 and the train service wage at 27½ cents per mile run. Working eight-hour tricks the number of helpers required would be:

HELPER ENGINE REQUIREMENTS

Length of Grade, miles	Number of Trains per Twenty-four Hour Day		
	Ten Trains	Twenty Trains	Thirty Trains
2½	2 helpers	3 helpers	4 helpers
5	2 "	4 "	6 "
5	3 "	6 "	9 "

And the relative cost per day of twenty-four hours for the two types of service would be:

RELATIVE COST OF HELPERS AND DOUBLING

Trains per Day	Type of Service	Length of Grade		
		2.5 miles	5 miles	10 miles
Ten	Helper Doubling	$50.00 13.75	$50.00 27.50	$75.00 41.25
Twenty	Helper Doubling	$75.00 27.50	$100.00 55.00	$150.00 82.50
Thirty	Helper Doubling	$100.00 41.25	$150.00 110.00	$225.00 165.00

18. Obsolete Lines.—It is natural that in view of the speculative character of some of the construction; the disappointments in the traffic development of some regions; the exhaustion of traffic resources in others, when dependence was placed upon timber, minerals or particular industries; the construction of competing lines, with consequent division of business and the development of other means of transport through the building of good roads; the use of automobile passenger cars and trucks and for similar causes; that a significant percentage of the lines built in the past no longer have an economic defense for their existence. Doubtless we should be much better off if about 25,000 miles of track were dismantled, the materials put to more profitable uses, the relatively well-graded roadbeds converted into highways and the communities served therefrom. Something of this has been done in recent years, but the resistance of public authorities and communities has been both shortsighted and selfish, and little real progress has been made in what is a sound and necessary economic step in our industrial progress.

19. Passing Sidings.—While I was a division engineer, my superintendent, when on a vacation, made a trip over the Chesapeake and Ohio Railroad, and meeting a brakeman who had formerly worked for him, asked why he had left the

Chicago Division. "Well," the man replied, "I liked it there all right but you didn't have sidings enough."

How often has this complaint been echoed by officers! Passing sidings should be installed at intervals of approximately five miles on single and ten miles on double track, should be ample to accommodate one or more trains, as the dispatching requirements demand, and should be kept in condition but little inferior to the main track. These requirements seem simple, but how seldom are they realized! As road delays consume about one per cent of the life of the car, that is, withdraw from useful service 22,418 cars of the total, 2,241,755 (on March 1, 1920), and as these delays are, to a considerable extent, due to lack of passing siding accommodations, their provision ought not to be neglected.

The additional tracks for passing movements are so substantial a percentage of the main track (say 25 per cent to 40 per cent, depending on length of freight trains and density of traffic) that care should be taken in their construction to permit of their absorption in future main tracks, on single tracks by the use of corkscrew laps, and in all cases with careful consideration of gradients and curvature.

As the traffic on the single track becomes heavy, operating facility will be greatly served by the installation of lap sidings. While on the Cleveland and Pittsburgh Division, I made a complete installation of lap sidings, numbered the switches, used the switch numbers in train orders and described their use at the time as follows:

In complying with your request to give you some account of the "lap sidings" in use on this Division, some statement of the general situation seems necessary. The Cleveland & Pittsburgh Railroad, operated as one division of the Pennsylvania Lines West of Pittsburgh, is still further divided into three operating divisions, viz.:

The Tuscarawas Branch, 31 miles long, on which three trains are run in each direction daily, built through a fine agricultural valley a generation since, when it was thought that the transportation of the products of the farm would alone afford a profit.

The River Division, running for 94.5 miles along the Ohio River, with a heavy local traffic, and receiving on the upper 25 miles a large accession from the main line. While the curvature is, of course,

great, the low grades (maximum 20 ft.) enable us to haul with consolidation engines, carrying 41 tons on the drivers, trains of 60 cars each, and so reduce their number that the problem of road service is a small one.

The Main Line from Cleveland to Wellsville, 101 miles, with its 153 curves of from 1 to 7 deg.; with its undulating gradients, varying the westbound trains 19 cars Wellsville to K N tower, 30 cars from that point to Hudson, and 36 cars from Hudson to Cleveland, the east-bound being uniform at 24 cars; with the lading consisting chiefly of coke, coal and iron ore, making the average carload 20.8 tons, the inertia excessive, and the braking difficult, and with an average of 52 trains daily throughout the year (27 per cent being passenger), reaching frequently during the autumn 65 trains daily, and occasionally as high as 78, all of which must do work at seven first class stations is, as Kipling says, another story.

With the large and continuous growth in the business and but little change in the motive power, no addition to the track facilities had been made for many years until, in 1889, the question was taken up in earnest and the work of improvement vigorously prosecuted. The accompanying profile and plan show the situation as it was in 1889, and as it is at the present time, indicating the location and capacity of the passing sidings and the direction in which trains enter them when moving on their schedule rights. The short section showing alignment is taken from the most favorable portion of the line, the tangent on either side of Macedonia being the longest on the division.

In locating the passings, lines were drawn on the profile at intervals of five miles, and the location then shifted in case the grades demanded it. No attempt was made to retain them at the stations, and we now feel a distinct relief in cases where they were moved out into the country, as almost every temptation to kill time on the siding has been removed. We still feel, for example, the effect on the movement of the lunch counter at Alliance. In some cases, as at K N tower, the siding was located at the point to which trains backed to make a run for the hill, in cases where formerly they had frequently stalled on it, entirely removing that difficulty. The removal of the sidings from Macedonia Hollow abolished the point of greatest danger on the road; and whereas, formerly, accidents at that place were of frequent occurrence, we have had since the reconstruction no accidents at Macedonia, Bosworth or Wheelock.

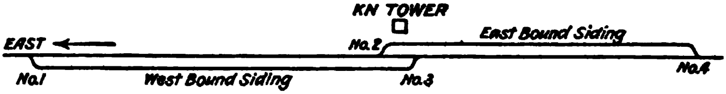
The location of our grades prevented our following the plan adopted by Mr. Turner on the Panhandle of having the trains in all cases feed toward the tower. (See *Railroad Gazette*, Sept. 12, 1890.) For example, at McGarry, a westbound train moving toward the tower and using the siding would lie for its entire length on the grade and would pull out very slowly and with great difficulty, and

this is true of various other places. At nearly all the laps the two switches at the lap are governed by Stevens' levers in the tower, and a copy of the order putting the train on the siding is sent to the operator, who, in locations like McGarry, opens the switch for the train, which is thus able to enter the siding at about 10 miles an hour, and when released to drop out quickly. It is true that the engineer of the first section would, in case there were orders for him, have to walk back a half mile for them; but we are able usually to avoid sending orders to trains using the siding under this condition, and find this cause of delay but trifling, while the gain in time of movement is very considerable. We estimate a saving of eight minutes at the meeting point by having the operator control the switches and of six or seven minutes by avoiding the slow movement on the adverse grade. An advantage of 15 minutes in single-track movement is a great desideratum, often meaning the success of the entire trip.

We find the advantages of the lap sidings all that you claim for them in your article of Sept. 12, but feel that we have greatly increased their natural usefulness by our method of operating them. At first we numbered consecutively all main track switches, and meeting points were made, for example, at Salineville No. 10; but we felt this method to be hazardous as requiring an exact knowledge of many very complex situations, and finally adopted the following rule, which we placed upon the time card:

Only those switches connecting sidings with the main track at which trains are to be met by special order are numbered; No. 1 being the most easterly switch, and the numbers increasing toward the west. When trains meet at a numbered switch by special order, the train that can enter the siding without backing must do so.

This rule, in connection with the lap sidings, gives the despatchers a masterful control over the train movement, to what extent may perhaps be most easily made clear by the quotation of a few orders. Eastward trains have the absolute right of track under Rule 84. Trains 37 west, 38 east passenger, and 118 east freight, meet per schedule at K N tower.



SWITCH AT KN TOWER.

Under normal conditions No. 37 would take siding at No. 1, No. 118 at No. 4, leaving the main track clear for No. 38. The lap avoids the backing out of the siding by No. 37 and enables it to pull out directly No. 38 has passed. Frequently, however, No. 37 is a trifle late. To hold it back at Summitville would delay it badly

and 118 worse. Ordinarily it would be helped out by a time order against No. 38, and both trains be delayed while it took the siding. We make the movement by meet order:

"No. 37, engine 16, and No. 38, engine 14, will meet at K N tower, No. three (3)."

The order is short and explicit; the lap avoids the backing out of the siding by No. 38 and the use of the numbered switch avoids any delay whatever to No. 37 and does not add to the delay of No. 38.

If No. 38 be late, the order would read:

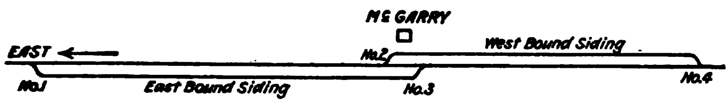
"No. 37 and No. 38 will meet at K N tower No. two (2)."

"No. 38 will run 10 minutes late, Bayard to K N tower."

"No. 37 will wait at K N tower No. three (3) until three fifty-seven (3:57) p.m. for No. 118, engines 88 and 63."

No. 37 is advanced a half mile westward, No. 118 is advanced three-quarters of a mile eastward, and No. 38 suffers no detention. This order is not often given under these conditions, but it is given with frequency, when freight trains in each direction and one passenger train are to meet.

I said that we refrained as far as possible from sending orders to trains at points where they feed away from the tower. We often make this movement: No. 123, freight, is due at McGarry at 10:56 p.m., and is scheduled to meet No. 124, freight, due out at 10:56 p.m., and No. 88, freight, due out at 11:32 p.m. The order would read: "No. 123, engines 2, 31, 38, 90 and 35, First and Second No. 124, engines 61 and 42, and No. 88, engine 26, will meet at McGarry No. four (4)."



This puts the eastbound trains on the westbound siding and heads the engines past the tower, where they can get their orders.

No. 36 and No. 2 are eastbound passenger trains scheduled 10 minutes apart, No. 2 leaving the division at Hudson for Columbus and Cincinnati. Frequently they meet delayed freights at B Q tower, and an order is sometimes issued making a double track movement, the switches at the lap being thrown for the sidings by the operator. Substituting K N for B Q, so as to use the figure above, the order would read:

"Nos. 36 and 2 will wait at K N tower until eight forty (8:40) a.m. for 1st, 2d, and 3d 123, engines 25, 38 and 46, and No. 89, engine 26; Nos. 36 and 2 will take siding at K N tower No. four (4)

and 1st, 2d and 3d 123 and No. 89 will take siding at K N tower No. one (1)."

As a rule, our freight trains are run in convoys of three sections and the sidings are built to hold three sections of loads, all the cars figured at 37 ft. It often happens that we are hauling a good many empties eastward, in which case it becomes necessary to sidetrack these trains on the longer westbound sidings, which is readily accomplished by orders similar to the example of one given at McGarry. In fact, a considerable number of combinations will at once be apparent which will go far towards explaining our experience that it is next to impossible to get trains in such shape as to cause a block at one of our passing sidings.

Of course, the questions always asked of any new scheme are, What did it cost? What are the results? Is the first justified by the last?

We did some work on every passing siding on the division. Some were simply lengthened out, the main track shifted in position and the lap formed by a cross-over. At some points a new siding was built on the opposite side of the main track, and in the majority of cases new sidings were built entire in new locations, the material from the old ones abandoned being used in the new construction. Great care was taken to locate them so that they might eventually be incorporated in the future double track, this being in every case insisted upon. The entire cost of the 15 sidings, including additional right of way, bridges and culverts, grading, track, telegraph towers and the machinery at the towers, was $81,757.47 (including estimated cost of sidings at Earlville, not yet completed).

The most evident results may be said to be:

First. An added safety to the dispatching, as many of the orders are sent to the operator as well as to the trains crews, adding this additional check to those provided in the uniform rules.

Second. The arrangement for the passing of trains at the meeting point is made by the dispatcher, the one man who has a full knowledge of the entire situation, in a concise and perfectly definite order, saving time in the transmission, and giving celerity to the movement.

Third. The better location of the passing sidings avoids many and extensive accidents, the precise money saving from which it is impossible to estimate accurately, but which may be approximately estimated from the following figures:

Wrecks	Total Cost
1890, 11 months	$6,447.40
1887	16,967.42
1888	6,898.28
1889	2,233.95

Fourth. Each westbound freight train will average four meeting points on the road in which with the usual straight sidings the trains will first pull into the siding, then back out and then pull ahead on the main track, running in each case 1.4 miles, which are avoided by the use of the lap sidings. Limiting this extra mileage to the westbound freight trains, though it frequently applies to westbound passenger, and sometimes to eastbound freight, we have for the daily movement a saving of 106.4 miles. Wellington, in his "Railway Location," page 170, gives the average cost per train mile for the roads of the United States at 90.3 cents, of which the items involved in the movement under consideration amount to 43.93 cents per train mile; the wages of engine and train crew being taken at the present average proportion of overtime. As these figures are for the mileage between terminals, and include the extra running at passing points, they should be here reduced to 41.6 cents per train mile when the total distance run is considered. This would show for the 19 daily average westbound freight trains an expense of $44.26 and for the years of 300 days $13,278.72.

Fifth. Prior to February, 1888, we paid overtime after 12 hours; since that date the runs have been divided on the basis of a speed of 10 miles an hour and overtime paid on that basis, making it accrue on this division after the train has been on the road 10 hours. Under the present practice the overtime for November, 1887, would have approximated $2,000.

The amount paid in November of each year is as follows:

November, 1887	$ 964.08
November, 1888	1,767.65
November, 1889	1,407.30
November, 1890	394.02

The problems of conducting transportation, as I understand them, are to move fast and slow traffic over the same piece of track, and to so arrange the making up and work of the trains as to secure punctuality and despatch.

For the solution of the first problem for single track roads we offer, in the language of the patent attorney, what we believe to be a new and novel invention, being a combination of the lap siding with the use in train orders of numbered switches.

By the use of the lap sidings, with an investment of about $80,000, we raised our average speed from 10 to 14 miles per hour. The effect of the right-of-track precedence given by the time card to eastbound trains was that the freight trains averaged 14 miles per hour eastbound against an average of 13 miles per hour westbound, or an advantage of about eight

per cent. It was a smartly operated division and, though the operating conditions were quite severe, was well up in the first flight of the performance of that day. I went to the division as division engineer and was there sixteen months before I became superintendent. My predecessors had been devout Sabbatarians and for many years no trains had moved on the property on the Sabbath Day. The difference between the number of cars moved over the road during the week under the six-day and the seven-day operation was very much less than I had looked for. There was, after all, but six days' business to move because of suspension of business on Sundays by the community. The change was reflected in the speed rather than in the volume of the movement.

The superior rights given to passenger trains and the character of their road work is reflected in the difference between them and the freight trains in delays between terminals, the delay to the freight trains on single track roads being about four times as great as that to passenger trains.

20. Flying Junctions and Interlocked Crossings.—Much is added to the safety of the operation, and time saved and facility of movement insured, by the elimination or control of conflicting movements. Where possible the grade crossing should be eliminated by the use of the flying junction or "jump-over" or by a separation of grades. Where this is not practicable, interlockings should be installed. Similarly the use of spacing signals may be of great usefulness on tracks of much curvature or heavy grades.

21. Track Capacity.—The question is often raised as to the number of trains that can be moved daily over single- and double-track lines, properly furnished with the necessary facilities. The main limitations on track capacity are the differences in the speed of trains, the amount of shifting and local work that has to be done, and the promptness with which trains are taken into terminals. On the Cleveland and Pittsburgh Division, single-track and with trains varying in speed from 10 to 40 miles per hour between terminals, we frequently moved in the summer over portions of the line

70 trains daily (Sundays excepted) and felt that we could have moved in excess of this number. There was much discussion on the Pennsylvania Lines as to track capacity. Mr. McCrea had made an investigation in 1889, and I conducted another in 1898. The conclusion reached was that while the capacity might be taken at 60 trains daily (¼ passenger, ¾ freight), double-tracking, which has to be done gradually, should begin when the movement on single track had reached 40 trains daily. It should first protect approaches to terminals, long maximum grades and other natural points of congestion, and portions of the line where the time card creates many meeting and passing points. The character of the traffic, percentage of passenger and fast freight trains, length of freight trains, grades, and other conditions make the estimate at best an approximate figure.

A double-track railroad, the cost of which will exceed that of a single-track 60 per cent, and its maintenance 20 per cent, is not the equivalent of two single-track railroads. Many efforts have been made to utilize the double tracks in both directions by train orders. Unless great caution is used such arrangements result in delays and increase accidents, and the moral hazard is exaggerated so that the practice does not generally obtain. The effect in expediting the movement is so great that no hesitation should be felt in resorting to the practice if safeguarded by proper signal indications. It is generally advisable to add more tracks when the number of trains exceed 90 daily.

A third track can be used in both directions and this operation is frequently successfully practiced. In many cases the third track is used in one direction for one period of the day, and in the opposite direction during another period of the day, either by time card or by train order, and with greater or less installation of signaling. It is also in places used quite extensively as a single track by train orders. The third track adds considerably more than 50 per cent to the capacity of a double-track line, and the three tracks have something more than treble the capacity of a single-track railroad.

When the trains moving over a railroad exceed approximately 150 per day, the installation of a four-track system should be begun. Care should be taken to arrange the tracks so that fast and slow trains may be crossed from track to track as occasion may require. Under any conditions the capacity of a four-track railroad will be considerably more than twice the capacity of a double-track railroad. If approximate uniformity of speed can be arrived at by segregating the trains on the two tracks in each direction, the use is vastly increased and conditions approximate those on elevated and subway railroads. Under such conditions a movement of 400 trains per day might be reached.

In building its four-track railroad between Albany and Buffalo, the New York Central arranged to operate as two double-track lines, running the two southerly tracks in the right-hand direction for double-track and the two adjoining northerly tracks in the left-hand direction for double track. This arrangement largely increased the conflicting movements in diverting trains from one main track to another in order to effect passing movements. The situation was somewhat relieved by the installation of passing sidings, but the lack of flexibility in operation and the delay in restoring normal movement after interruption led to the gradual remodeling to the normal arrangement, the work being still unfinished on the Mohawk Division. The handling there is about 140 trains per day, 77 passenger and 63 freight, of which 30 are fast freight. On the Pennsylvania Railroad the two southerly tracks are operated as eastbound and the two northerly tracks as westbound tracks. The flexibility is much greater, as is also the capacity for movement. The normal movement of the New York Division is 340 trains per day, of which 235 are passenger and 105 are freight.

It is customary to work out problems of track capacity for individual cases by "graphic" method. Several mathematical formulae have been proposed but are so affected by local conditions as to have no general application.

Of the life of the car, 11.4 per cent is spent upon the road; of this time, delays account for 1.0 per cent and normal

movement for 10.4 per cent. The equivalent of 255,560 cars is rendered useless by delays. To the extent that these delays can be eliminated or the normal movement quickened, these cars have their usefulness extended. This in itself will justify the expenditure of considerable thought and money; and there are besides many incidental economies.

22. Water Stations.—At intervals of about fifteen miles facilities must be installed for furnishing water to the locomotives. The old practice of taking water direct from the tank should only be practiced where the traffic is light. Standpipes should be so installed that water may be taken whether standing on the main track or on the siding. To insure prompt filling of the locomotive tank, standpipe and supply pipes of ample diameter must be used, say twelve inches or fifteen inches. Water stations on single track should be placed on the north side of the track for protection against the weather so that the standpipes and fittings may face south.

23. Track Tanks.—For the service of fast passenger engines, Mr. John Ramsbottom, chief locomotive superintendent of the London and Northwestern Railway, in the early 1860's installed track tanks from which water might be taken without slackening speed. In installing troughs it is important to have the track perfectly level and the ends raised about one inch above the balance with a run-off of 100 feet. The water in the trough is kept from freezing in winter by being heated before entering the pipes leading to the troughs and by being kept constantly in circulation. The pumping and circulating station should be located as nearly opposite the center of the trough as possible. The locomotives are equipped with high-speed balanced scoops, operated by air pressure, through which water can be taken from the troughs at speeds of 45 to 55 miles per hour, or with what may be called low-speed scoops adapted to speeds of 25 to 30 miles per hour. The high-speed scoops take up 2¼ to 3 gallons per lineal foot of trough; the low-speed scoops from 1¾ to 2 gallons. At speeds below 20 miles per hour more water is wasted by slopping over the sides

than is taken up by the scoop. At a speed of 45 to 50 miles per hour the amount wasted becomes minimum, about 625 gallons being taken up per inch of immersion of a 13-inch scoop in a 19-inch track tank, 1,000 feet distance, or say 2,500 gallons for a 4-inch immersion. The amount of water to be taken and the speed at which trains approach the trough determine its length. The length varies from 1,200 to 2,500 feet; it should not be less than 1,500 feet. Tests showed that it required from five to nine minutes more time for a freight train with full tonnage if it stopped to take water. There has been no substantial change in the practice with regard to track tanks in the last twenty years. Meantime the tenders have increased in size from 4,000 gallons to 10,000 and 15,000 gallons water capacity. If the trough is to be kept within reasonable limits as to length, relief must be had through widening. It is kept narrow to permit tamping ties. However, with modern pneumatic tamping devices the space for this purpose can be reduced and this would permit some widening of the troughs. Provision could be made also for supporting the track on a permanent structure such as is provided in tunnels, and this would permit a track trough relatively much wider, so that considerable improvement may be looked for in the near future. The use of track tanks cannot be expected to reduce the running time of freight trains over a division of 100 miles by more than half an hour.

24. Water Supply.—The matter of an adequate and sustained supply of water increases in importance as the country is cleared of forest growth and as the traffic grows and other demands are made upon the available resources. Some companies, but a very few, have faced this question with foresight and courage. In 1903 there was a period of prolonged and severe drought in the Eastern States. Almost all the roads were compelled to haul more or less water to eke out their meager supply. Mr. Cassatt, who always "bored with a large auger," at once organized several water companies, raised $20,000,000 by the sale of bonds and on a comprehensive scale insured the future of his road for many years.

Emerson says that "an institution is but the lengthened shadow of a man," and certainly on every hand the Pennsylvania Railroad reflects the personality of three great presidents—J. Edgar Thomson, Thomas A. Scott and Alexander J. Cassatt.

25. Water Treatment.—Innocent as water appears, it often carries acids, minerals, or sediments that are, in transportation, a source of endless trouble. The engine is delayed for washing, rinsing, and blowing-out; repairs and renewals are increased in cost and frequency because of pitting, corrosion, incrustation, and overheating, while the scale may cause a loss of heat as high as 10 per cent and threaten mudburning to sheets and staybolts.

Water contains impurities in varying quantities, carbonates and sulphates of lime and magnesia, sulphuric, and other acids, and is one of the most constant and pernicious of the enemies of the locomotive. Vaporizing water for conversion into steam precipitates these impurities, which incrust the surface of the tubes and the skin of the boiler, forming a "scale" that is difficult to remove. These precipitations occur when the concentration reaches about 100 grains to the gallon. The protection of the steel of the flues and boiler from the fierce heat of the fire depends upon the presence of water on the other surface to absorb the heat and prevent the temperature rising to a destructive height. When the water side of the metal becomes incrusted with this scale, conduction of heat to the water is much less free, the metal is more highly heated, and its deterioration or destruction more rapid. To mitigate these evils, the boilers are mechanically cleaned at suitable intervals, the water is subjected to chemical purification, or treatment, before it is put in the boiler, or treated in the boiler itself by the introduction of some form of "boiler compound."

On many roads the annual cost for fuel, repairs, boiler washing and lost service is increased $1,000 for each locomotive, justifying a considerable expenditure for the proper treatment of water. The benefits derived from the treatment of water are the prevention of leaking tubes; the longer life

of flues and fire-box sheets; reduction in the washing of boilers and in their repair; an increase in locomotive mileage between shoppings; a decrease in the number of locomotives required for a given service; a decrease in delays and overtime and a saving in fuel.

26. Coal Tipples.—On many operating divisions a supply of coal must be furnished the engines between terminals. It is good practice in such cases to install a really substantial outfit. Coal should be delivered both on the main tracks and sidings, and the water pipes handled from the bridge. In a well-designed plant the time taken to supply coal and water to an engine should not exceed three or four minutes. If it is also necessary to clean fires, ash pits should be installed, with facilities for handling the ashes. In northern climates care must be taken to safeguard these devices from freezing.

27. Telegraph and Telephone.—There are few facilities in more constant use by the transportation officer than the telegraph and telephone. Special care should be taken to insure that these are ample and constantly serviceable. At terminals a company exchange or private installation is usually justified. The time of trains on the road is affected by the number of telegraph stations and the distance between them. So little attention is given to this important matter that on adjacent divisions differences as great as 25 per cent may be found in the provision of passing sidings, telegraph stations and other facilities.

28. Stations and Service Sidings.—Much greater care is warranted than is shown as a rule in the location of the station building with reference to the community served, its floor plan, and the consolidation of the numerous small structures usually found scattered about station grounds. The space allotted to the agent should be ample and furnish room for the orderly filing of numerous records and stationery, and where train orders are handled a separate entrance and lobby should be installed. While the floor plan of the station should be prepared or approved by the transportation officers, the elevation and general construction of the

building should be the work of a competent architect. At an additional expense of no more than 7 to 10 per cent, a factory-like structure may be transformed into a building of architectural distinction.

Local depots should be far enough from the main track to allow ample space for waiting and discharging passengers. Platforms should be not less than 16 feet wide, preferably 20 feet.

Service sidings are usually built solely for convenience of traders and without regard to handiness in shunting, and frequently conditions might be substantially improved. Most industrial establishments are very much undersupplied with trackage, platforms, and handling devices, and have thrown upon the railroads a large amount of work and consequent delay and expense.

29. Track Scales.—It is probably safe to say that all roads are insufficiently provided with track scales on which both loaded and empty cars should be weighed in order adequately to protect their revenues. Though an item of expense both in installation and maintenance, they will be found to justify any reasonable outlay that they occasion.

Many of these scales are light, having sectional capacities of from sixty to seventy-five tons and are in use when comparatively few cars are to be weighed. The more modern ones are heavy, having sectional capacities of from 75 to 100 tons and meet the usual demands of railroad and industrial installation. There are special cases where, both as to character of construction and capacity, the ordinary practice is departed from.

With lengths varying from 50 to 60 feet, cars are usually weighed while stationary, being spotted to secure accurate weights. When in motion the speed should not exceed 4 miles per hour, and each car is weighed while alone on the scale.

Master scales are provided at suitable points so that the scale-testing car can be properly checked. Manufacturers' tolerances are allowed on all new track scales of fifty pounds per 100,000 pounds for any position of the test car load.

Adjustment tolerances of ten pounds and maintenance tolerances of fifteen pounds are allowed in testing practice. Care should be taken to prevent creeping of the ends of approach rails or accumulation of refuse or anything interfering with free working.

30. Interlocking and Block Signals.—Signals are customarily described as fixed and movable, which is correct enough but serves no useful purpose. They are, more accurately I think, first, those that indicate the condition of the track, whether in normal condition, in abnormal condition and unfit for use, or occupied by a train or other obstruction and unsafe for use, such as flags set by bridge and section men, switch targets, interlocking or block signals, and flags, fusees and torpedoes used to protect a standing train; and second, those intended to direct movements of trains, as the train order signal and the green and white classification signals. At the outset we imported our interlocking, an invention of John Saxby in 1856, and our block signaling appliances from England. They had not come up naturally in the development of the railway, but were introduced arbitrarily by orders of the English Board of Trade. In importing them we had to adapt them to our practice. The genius of the American system of train operation is that always the direction is to *go.* This movement of the train is made under the authority of the division superintendent given by the time card; the green classification signals put on by the yardmaster acting for him; the white classification signals put on by the train orders given for him by the train dispatchers; and by train orders issued through the operators, the existence of which is signaled to the train by the train order signals. The movement is subject to interruption by the condition of the track, which may be physically unfit for use or may be occupied by another train, and this condition is made manifest to the train crew by hand signals, flags, switch lights, interlocking semaphore arms, block signals, or other devices. No one has ever thought that if a switch signal was changed an engineman would feel that he should go from the siding to the main

track if he had a train order for a train coming there against him. And so for the indications of interlocking and block signals. If we make this distinction definite we get rid of a large amount of confusion in dealing with this intricate subject. It does not direct the train movement in any such sense as does the time card or a train order.

Signals indicate the condition of switches, the position of trains, etc. Having this information, those in charge of the train know when to start, when to go ahead at speed or under control, when to reduce speed, and when to stop.

The practice of having only two blades on a post, which came to be almost universal for a time, has been departed from in some cases, I think to the detriment of the plant except perhaps in the addition of the "calling on" arm or "lazy board."

The old single order system of dispatching, though placing too much responsibility on individuals, promoted great expedition of movement. The double order system slowed up the movement substantially and has of late years been quickened by the free use of the "19" order handed up to the engineer and conductor by "hoops." Fully one-half the train orders now issued are "19" orders.

When I patented the "Upper Quadrant" signal I looked forward to the use of a butterfly signal for train movement by a combination of train signals in the upper and low quadrants, giving five direction indications. These would cover the more important movements as substitutes for the present form of train order and greatly quicken the movement.

Beginning about 1880 there was a very rapid development and installation of interlocking and signaling devices. Charles R. Johnson, who had been with the Saxby & Farmer concern, came over to this country, finally establishing a signal company of his own George Westinghouse organized a signal company and brought out his electro-pneumatic apparatus, while several companies were busy developing electric and mechanical systems. This naturally resulted in a wide variety of practice, and, at the beginning of 1889

Mr. McCrea appointed a committee, on which I was so fortunate as to serve, to recommend a standard practice for the Pennsylvania Lines. The report was submitted in February and went far to inaugurate the present practice. The principal features were the organization of a signal department; a separate post for each track to be governed, with two blades on each post, the top blade to govern the main or high speed route, the lower blade to govern all diverging routes, indicators to be attached thereto where desirable; the painting of all semaphore blades yellow; and the use of illuminated blades, which subsequently proved impracticable. I brought away from these meetings one lesson that has ever since been prominent in my mind. There was one member of the committee who offered more suggestions than all the others combined, and all without exception had been rejected, sometimes after rather acrimonious debate. When we were going over the final revision this gentleman said he had one further suggestion to make and we all settled back in our chairs prepared to endure it. He recommended that "where overhead bridges were used, each post thereon should be located vertically over the right-hand rail of the track which it governs," and for the reasons that it would be more directly in the line of sight of the engineman and removed from the direct blast of the exhaust from the smoke-stack. The suggestion was unanimously adopted and without discussion. I have always felt since that one should have patience to listen to all suggestions which anyone has the courage and confidence to bring forward for discussion by his associates.

31. Terminal Depots and Adjuncts.—The large terminal stations and the large terminal yards are the graveyards of cars. Every effort should then be made in their design and administration to avoid reverse movements, unnecessary movements, and delays to make supervision easy and to promote prompt and free movement.

The depot may, and where possible should, include in one design:

1. A city station for delivering and receiving
2. A transfer station
3. A storage warehouse
4. A team-track yard

There are further to be considered:

5. Waterside and other special facilities
6. Private sidings and large industry sidings

1. Under American practice the platform upon which outgoing L.C.L. freight is received is normally cleared three or four hours after the closing hour for receipt of freight, but the platform upon which incoming L.C.L. freight is received is usually a sad mess. Seldom more than 50 per cent is taken away by the consignees on the day of receipt, and it is four or five days later before the last has gone out of the house. As a consequence, substantially more than one-half of the platform space is cluttered with delayed freight, which is very much in the way of the working force. In England, with their "collection and delivery" practice and provision for storage, one platform is used for both incoming and outgoing freight and is cleared of either class of freight in about the same time. The general economies of this practice are so great that we may anticipate its future introduction at our large depots. A convenient width for the incoming platform is 50 feet and for the outgoing platform 30 feet. The foundation walls may be carried up slightly above the floor level and filled in with sand, topped with 12 inches of engine cinder to prevent rats working under the floor. In the cinder 4×6-inch mudsills may be laid on 3-foot centers, to which are spiked 2¾×8-inch flooring, over which is laid heavy tarred paper, and on this for easy trucking 1-inch dressed and matched maple flooring of short (3 feet) lengths. A wheel guard of 8×12 inches, to protect the masonry, should be installed. Scales should be placed near the doors at intervals of 100 feet. The doors should be continuous and either of the jack-knife or rolling type, with windows above. A room should be provided for unclaimed freight and an ample record room in which waybills and

other reports can be kept for the six years required by the Interstate Commerce Commission. This should be arranged to keep the records for each year handy for daily access and so classified that the clerks can, without interference with others, consult their own records. Each month the oldest of these sets are to be moved into the permanent storage. If the tracks are parallel to the depot, a 10-foot platform should be run along the house. The tracks may be laid on 13-foot centers, the cars spotted with the doors opposite and four or five strings loaded by trucking across, but it is much more convenient and permits faster loading if narrow (4 feet) platforms can be built between. If the tracks are at right angles to the depot the 10-foot platform is still necessary, and there should also be platforms between each pair of tracks. These isle platforms are preferably 16 feet wide with rows of columns in the centers carrying the shed roof. Large, easily-read signs should be placed at all receiving openings, indicating points for which freight is received, and near the delivery clerk's office, for directing teamsters to their cars, on a blackboard, should be indicated the position of all loaded cars on team tracks. To insure loading freight into proper cars the "return ballot system" should be used and the stevedore held to a strict accountability. It is practicable, with care, to reduce mistakes in loading to one-tenth of one per cent, or say, fifteen errors in 15,000 pieces handled. Paying for handling freight on a "tonnage basis"—an application of the piece-work system—secures better men, enables the work to be done with fewer men and helps to eliminate the sloth and disturber. Freight handlers should be taught to load cars with package freight so as to obviate shifting. The cars should be inspected before loading to see that they are clean. Greatly increased utilization of equipment may be secured by a proper loading system and placing freight in the right cars.

2. The transfer station is a facility for unloading, grouping and consolidating of freight, and reducing the number of cars used in its movement. The expense of a well-located, designed and operated transfer station is amply justified

by the quickening of the movement, the additional service obtained from cars withdrawn from the movement, and the saving in expense of the movement itself. The transfer should be made at the first available station reached and this should, if possible, be made a part of a terminal freight depot. In this way it is possible to take advantage of the labor supply, to have only one overhead organization and to utilize the freight for, or of, the terminal to build up the loading and enable prompt use to be made of the empties recovered. Care should be taken at these depots to load cars for designated trains and in station order, as frequently all switching on the initial line can be avoided and subsequent switching much reduced.

The best practice usually is to assign four cars only to a stevedore, who soon learns what freight properly belongs to those cars and errors in loading are reduced to a minimum.

At the larger transfer stations platforms are preferably thirty feet in width and a groove is run parallel with the edge, and six inches from the same, to hold the transfer bridges in place without blocking or bracing.

Where much heavy machinery or exceptionally heavy pieces are handled, a gang, usually known as a machine gang, is organized, and freight of this character is left in the cars by the regular gangs for handling by this special gang. Similarly, explosives, inflammables, and acid shipments are given special attention, one man being assigned to this work and being also held responsible for the proper placarding of the cars.

3. Terminals are usually located at cities of considerable size and importance that are jobbing centers for an area of country for 100 to 150 miles on all sides. Much of the freight received is broken up, assorted, repacked and shipped out to the countryside customers. It is very much to the advantage of both the railroad and the jobber if this work can be done at the depot and a suitable warehouse for that purpose is a justifiable utility, especially as it further utilizes ground already occupied. Here and there over the country such warehouses have been built. They are resources of

which the railroads have as yet taken but little advantage.

4. In the team-track yards sixteen car lengths may be considered the maximum for economy, and where the yard is some distance from the district switching yard, a track between pairs of team-tracks to make a place for switching or storage is often very convenient. Tracks may be on thirteen feet centers and the driveways thirty-five to forty feet wide, well paved and drained. A team yard should be furnished with wagon scales, cranes, preferably of the gantry type, and a platform at the level of the car floor with inclined runway for handling automobiles, harvesting machinery and other heavy objects on wheels.

5. The waterside business of the railroads forms for many of them a very substantial interest, and installations of coal and ore piers, grain elevators and other devices are often very extensive. Some of the cities, as New York, are served in a large measure by car-floats. In situations such as Chesapeake Bay and Lake Michigan, car-float transfers of many miles are maintained. On the Atlantic coast, the float bridge—intermediate between the track and the car-float—must accommodate itself to varying levels of the car-float, due to the tides, which range from four to twelve feet, and to the further difference in the submergence of the float when loaded and when light. With the heavier cars now in use many floats are loaded by two engines, loading both sides at the same time to avoid straining the float.

Very great attention has been devoted to designs of elevators, ore and coal loading trestles, ore and coal discharging and storage devices, as well as merchandise piers and goods-handling machinery, and examples of good practice are to be found in all parts of the country.

6. A considerable proportion of the shunting at a terminal is to business sidings and to large industrial plants. The traders, partly from motives of economy, and largely, I think, from lack of appreciation of its importance, have generally failed to provide themselves with adequate trackage, platform and floor space for handling their railroad business. It is the common experience that the roads hold

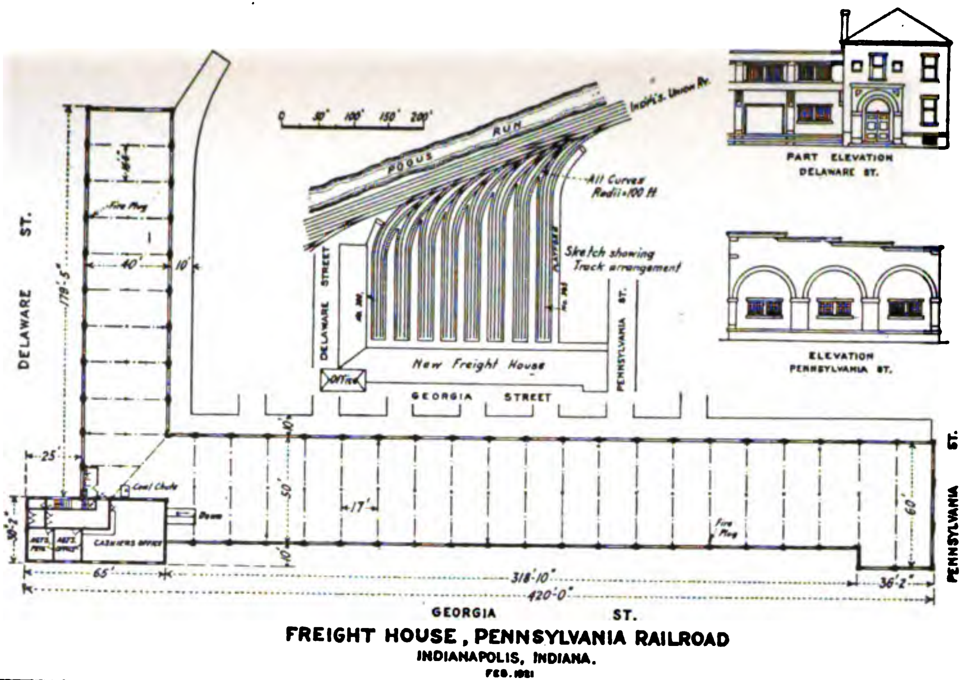


FIG. 3.—FREIGHT HOUSE, PENNSYLVANIA RAILROAD.

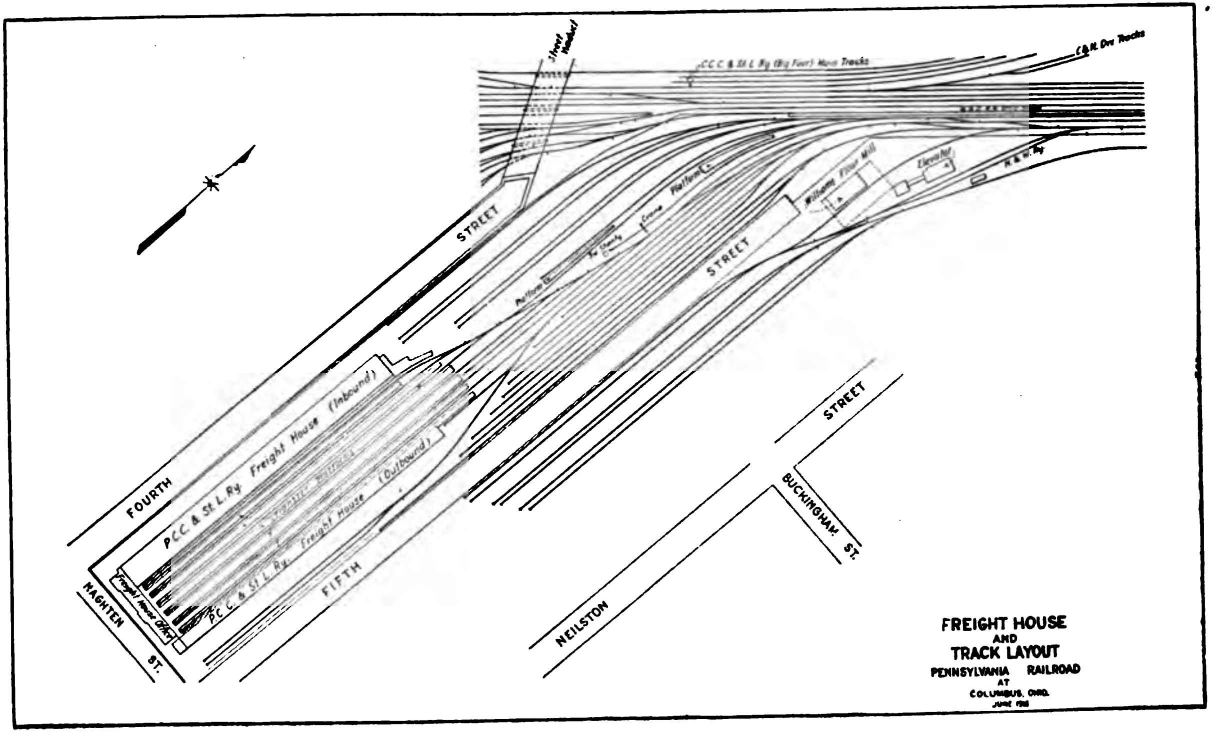


Fig. 4.—Freight House and Track Layout.

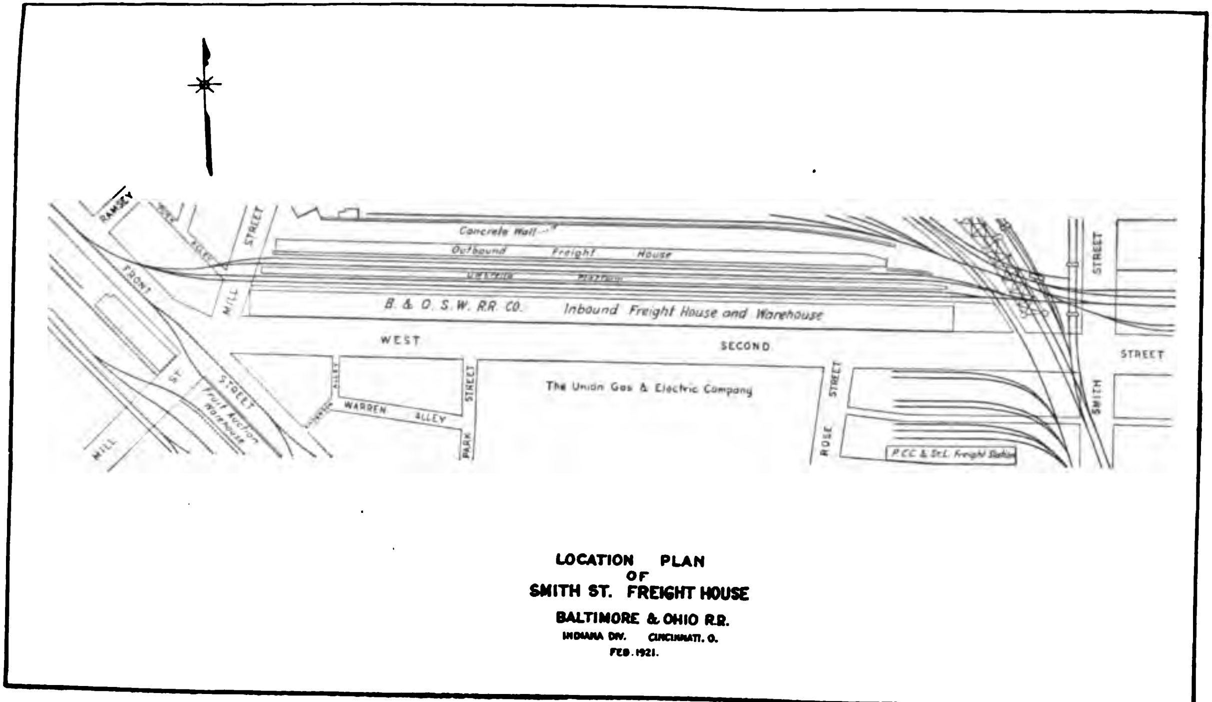


FIG. 5.—SMITH STREET FREIGHT HOUSE.

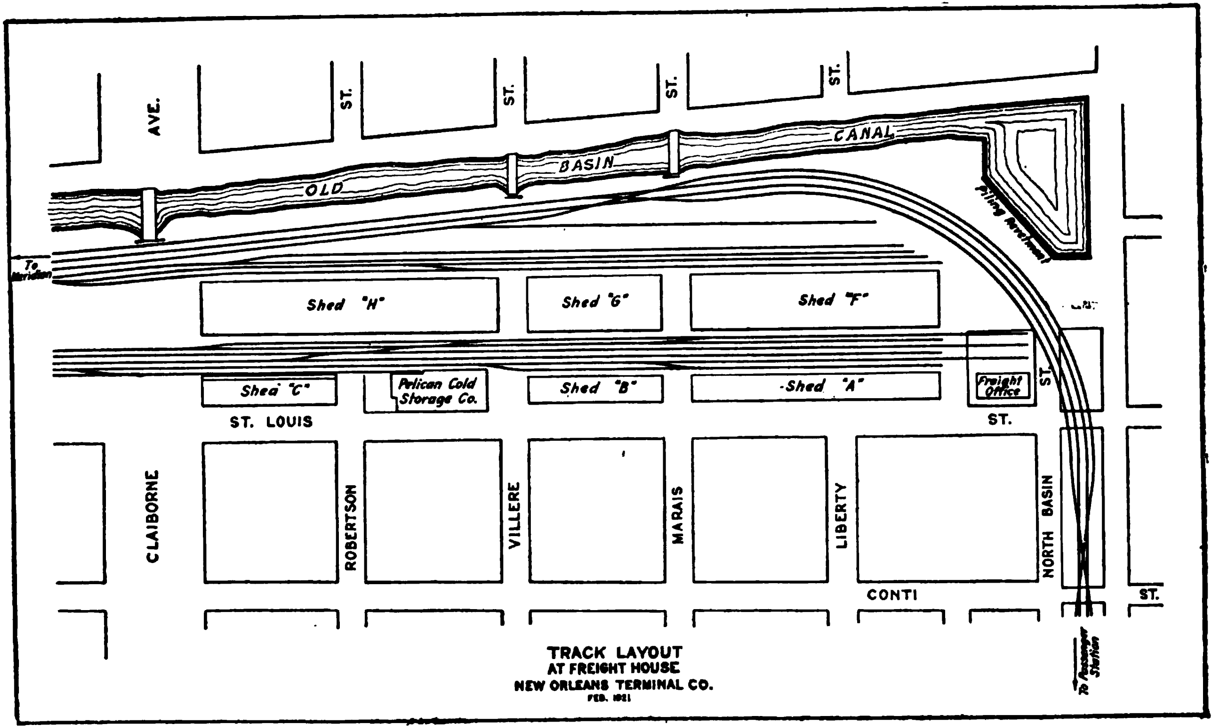


FIG. 6.—TRACK LAYOUT AT FREIGHT HOUSE.

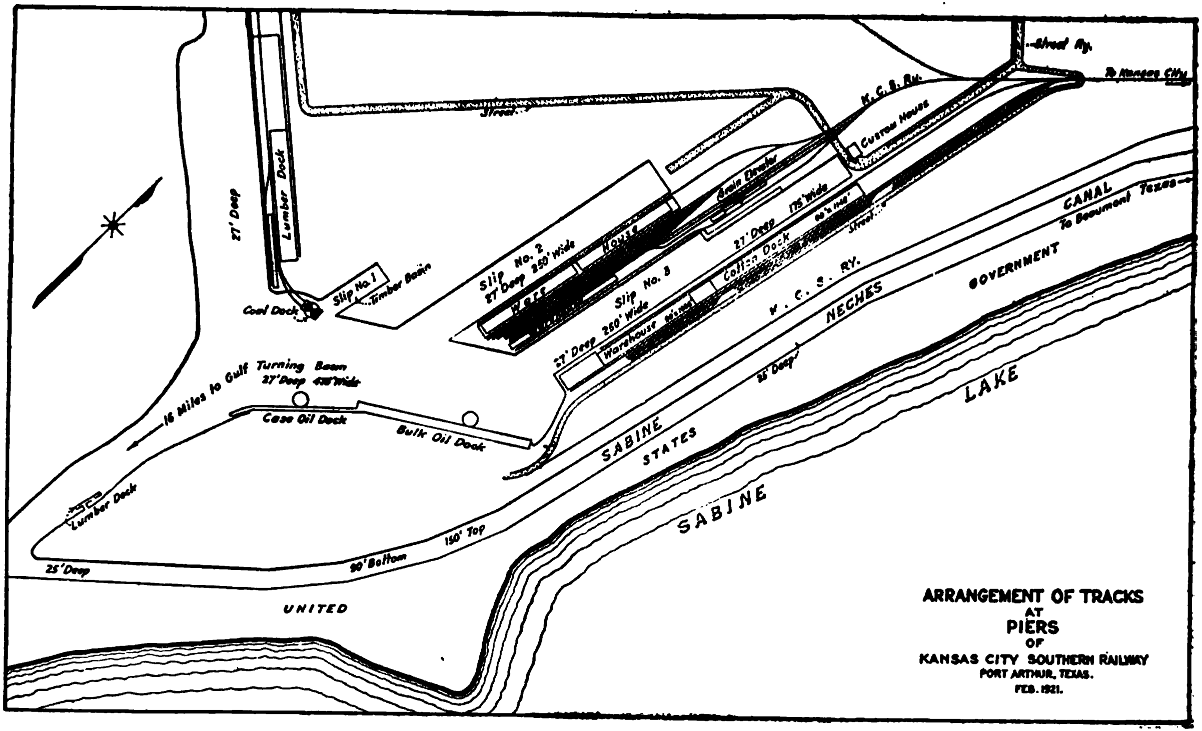


FIG. 7.—ARRANGEMENT OF TRACKS AT PIERS.

for consignees each day as many cars as they deliver, and, speaking broadly, the traders should at least double the facilities they use for this purpose. In "boom times" no one thing would do more to relieve congestion and render the existing car supply adequate. The least that can be asked of them is trackage not only sufficient to take care of a full day's loading and unloading, but adequate to permit the switching necessary for the different uses of the cars. Anything less than this is to transfer to the railroad, in largely increased amount, an expense that should be borne by the trader, and in "boom times" to subject both parties to serious inconvenience and loss. At the large terminals small switching yards for the service of zones or districts are often advantageously used and should be connected with the main terminal yard by running tracks.

Next to the terminal yard, there is no better opportunity for saving time than at the loading, unloading, and transfer points.

32. Terminal Yards.—The large terminal yard is the nervous ganglion of the division; here many things are done that make or mar its operation and here should be concentrated much of the thought, oversight, and activities of the divisional officers. It must always be kept in mind that the prime object of the yard is to keep cars in motion in the direction of their destination; that storage is an incident; and delay an evil.

Every yard handles a business and presents problems peculiar to itself. The conditions may be checked against the details here considered to make sure that nothing has been overlooked. The suggestions advanced show generally the methods adopted in my experience to meet different conditions.

The disposition of the main tracks with reference to the terminal yard is first to be considered and may quickly be disposed of. Are they to be made to:

1. Pass both tracks to one side of the yard
2. Pass one to one side of, and the other through, the middle of the yard

3. Pass both tracks through the middle of the yard, or
4. Encompass the yard with a track on either side

Tracks passing through the middle of the yard are objectionable only when there is a large amount of shifting between the two sides of the yard.

I now turn to questions which call for detailed answers. How is the yard to be operated? Is it to be by:

1. "Shunting," "tail switching" or "lancing"
2. Poling
3. "Hump" or "summit" (or a combination of two or more of these)
4. Gravity

In planning the yard what disposition shall be made of:

5. The engine house
6. Engine dispatching facilities: (*a*) coal, (*b*) sand, (*c*) water, (*d*) supplies, (*e*) inspection pit, (*f*) washing pit
7. Yard office
8. Car repair tracks
9. Caboose tracks
10. Track scales
11. "No-bill" tracks
12. "Hold" tracks
13. Transfer tracks for connections
14. Running tracks for light engines
15. Wreck train track
16. Sub-classification "gridiron" or station-order yard
17. Storage yard
18. Icing and stock pen tracks

What arrangement can be made for:

19. Receiving tracks
20. Classification tracks
21. Departure tracks, with adequate installation of air pipes for testing brakes

Shall there be facilities for:

22. Properly caring for trains passing through the yard without switching
23. Trains taking on or setting out cuts only
24. The make-up of trains to be switched at a farther point

What is the arrangement for:

25. Yard leads
26. Yard lighting
27. Telegraph and telephone service
28. Concentration of facilities

33. Yard Operation: (1) *Shunting Yards.*—While this method is used in perhaps ninety per cent of the yards of the country, it is relatively very expensive and hard on locomotives, cars, and lading. As other methods of switching, with their elaborate layouts, cannot economically be installed in yards through which less than 500 cars are handled daily, it seems destined to remain as our most common method. Its maximum attainment, averaging two cars per cut, is about 50 cars per hour.

34. (2) *Poling Yards.*—Poling was much in vogue twenty or thirty years ago, and was developed to its full possibilities. At first the pole was handled from the bumper beam but later a ram car about twenty feet long was used ahead of the engine and added much to the safety of the man using the pole and permitted its faster handling. It was equipped with four poles, two on each side, one set working forward, the other to the rear. In the busiest yards three engines were used, the train to be switched being placed on a track between two poling tracks, one engine working on each track, and alternating in poling cuts, the third engine being used to push up the train and to bring back to the poling point the men who rode the cars into the yard. The switches were operated by air and controlled by electricity from a keyboard of pushbuttons, handled by an operator in a tower, who, as well as the conductors, was furnished with telegraphic "consist" reports or, as they were variously called, "cut," "make-up," or "destination" reports. The maximum attainment of a poling yard, averaging two cars per cut, was about 100 cars per hour. Such yards gave place after 1900 to the "hump" yard.

35. (3) *"Hump" Yards.*—The "hump" or "summit" yard had long been in use in France, where it was known as

dos d'ane. The first in this country was built by the Pennsylvania Railroad in 1890 at Honey Pot, in the anthracite region, near Wilkes-Barre, Pennsylvania. It was a low "hump," about six feet high; the cars ran only a short way into the sidings and after the train was dropped over the "hump" the pushing engine came down the ladder and using the "ram" car and two poles pushed down the cars on three tracks at a time, to make room for the next draft. Its value was long unrecognized, but some of our Western Lines officers sensing its possibilities we installed a low "hump" at Bradford, Ohio, in 1900. This was followed by more elaborate installations with higher "humps" and almost at once its use spread rapidly, first superseding and then supplanting the poling yards. Its capacity is usually rated at 200 cars per hour, averaging two cars per cut, twice the speed of poling and four times the speed of "lancing," and it can, in emergencies, be crowded beyond this. The "hump" is helped very much if the classification tracks fall away from the ladder by even so little as 0.4 per cent. Where the classification tracks are flat the "hump" must be quite high, as a rule at least fourteen feet, and where severe winters with much snow prevail, often as much as twenty feet, the car resistance under these conditions being as much as double that of the summer. These high "humps" permit one great convenience, passing under the "hump" a track or tracks for the use of engines moving from the yard tracks to the ash-pit tracks. The initial falling grade after passing the summit is usually three to four per cent for 100 to 200 feet to insure a space interval between cuts that will enable them to enter the classification siding, the switch to be closed and ladder cleared before the following cut arrives. The remaining grade to the foot of the ladder decreases rapidly and is in effect a vertical curve. The long distance to the outside tracks and the resistance of curvature would suggest construction on a warped plane. Cars dropping from these high "humps" attain speeds of 15 and 25 miles per hour at the lead switches and must be handled by the

car droppers with great care to avoid violent contacts and damage to equipment and lading.

Resort may also be had to the practice at the Honey Pot yard of keeping the "hump" low and pushing the cars down the classification tracks, three tracks at a time. Track scales are located near the summit on the descending grade. The right speed for accurate weighing lies somewhere between 3 and 6 miles per hour, according to the skill of the weighman. At 4 miles per hour over a 46-foot track scale the rate is equal to about six cars per minute, and at 5 miles per hour, to about eight cars per minute. As many as ten cars per minute have been weighed by a skilled weighman.

One serious difficulty in operating "hump" and gravity yards is the high speed the cars attain and the necessity for good braking. With us entire dependence is upon the hand brake. In the Edge-Hill yard, the English "waggons" being equipped with brakes operated by a side lever, the men use a stick and their body weight in applying the brake. On the Continent reliance is placed in the *sabot frien*, a brake shoe or skid, having slight flanges on each side and so built that the car wheel runs up onto it, the car pushing it along on the rail and the friction bringing both to a stop. They are built in many styles (see Figure 8) and weigh from fifteen to forty-five pounds. I had some made and tested and they developed rather more braking power than one brakeman could get using hand brakes. We distributed them through several of our sloping yards and found them very handy for occasional use.

There is a great difference in the draw-bar pull necessary to move different cars. There is no better place to locate by inspection cars with excessive resistance than on the classification sidings of a "hump" yard. It would seem one of the easiest places to detect cases of badly cut journals, heated bearings, badly fitting brasses, excessive weight on side bearings and other conditions that increase resistance.

36. (4) *Gravity Yards.*—But few yards worked entirely by gravity exist in this country. The topographical condi-

FIG. 8.—"SABOT FRIEN" BRAKE SKID.

tions rarely lend themselves to such a solution and when they do resistance due to severe winter weather, which may increase as much as 100 per cent, severely diminishes their reliability in northern latitudes. Where they can be used they are beautiful instruments. The gravity yard designed and installed by Harry Footner on the London and Northwestern Railway at Edge-Hill, a suburb of Liverpool, England, in 1873, is the smartest working yard I have ever inspected and I have seen most of the large yards, not only here but in England, France, Austria and Germany. I had this yard inspected by one of my officers who was in England in 1913 and he reported that after a useful life of forty years it was still working in an incomparable way.

37. Yard Planning.—In the narrow sense in which the term is often employed, of conference and exchange of views and counsel between employer and employee, democratic association has always been practiced and especially by those anxious to avail themselves of all possible aids in working out better methods and practices. As Mr. Morrison long ago pointed out "no railroad yard should be constructed without the engineer in charge taking advantage of all the information possible to be gained from the superintendent down to the brakemen of the switching crew." In determining on a plan for a yard at Conway, I wrote a letter of instructions on November 15, 1897, constituting a committee and requesting a report by February 1 following. The committee consisted of the chief engineer and the superintendents, engineers and assistant engineers of all the divisions entering the yard. The superintendent in immediate charge of the yard acted as chairman and formulated the report. The committee met once a week to consider data and prepare plans.

They visited several large yards considered as exemplifying the then best practice, sub-committees meanwhile preparing detailed information covering: (1) statistics of the operation and traffic of the existing yard; (2) sketch plans of different suggestions for discussion by the committee; (3) such important articles on yard design and operation as had appeared in the technical journals and books during the

preceding fifteen years, abstracts from these articles being made, accompanied by sketches of the yards described, drawn to uniform scale and in shape to be readily studied by the committee.

After this preliminary work, the yardmasters and their assistants, and members of different crews picked by them, were invited to attend meetings of the committee to criticise the plans prepared and to offer suggestions. The plans as formulated and changed from time to time were consecutively lettered and the amount of work done and care taken is indicated by the final construction of the yard to Plan M-4. (See Figure 10.)

It has become the fashion in certain circles of late to talk much about "industrial democracy," with careful avoidance of a definition of the phrase. Industry, and especially industry carried on under corporate organization, has always been one of the most democratic of our institutions.

38. Yard Accessories: (5) *Engine House.*—The engine house should, if practicable, be located at the working yards. If not so located separate running tracks should be provided for locomotive movement. There should be independent ingoing and outgoing tracks and storage tracks for engines "white-leaded" or awaiting movement (see Figure 9). The office of the engine house foreman should be so located as to give him a view of the ash pit. As an example of what can be done to facilitate movement, I arranged at Conway (see Figure 10) a roundhouse with turntable in which we housed some passenger locomotives, local freight locomotives and engines requiring light repairs, and on either side additional turntables with engine lie-by tracks and engine dispatching facilities. Three divisions fed into the yard from the west and six from the east, and it was the customary practice for a locomotive arriving with a train to begin its return trip in an hour and a half.

39. (6) *Engine Dispatching Facilities.*—The close combination of the engine dispatching facilities, the coaling station, ash pit, sand and water supply, wash pit and inspection pit, saves much time and facilitates supervision. The coal

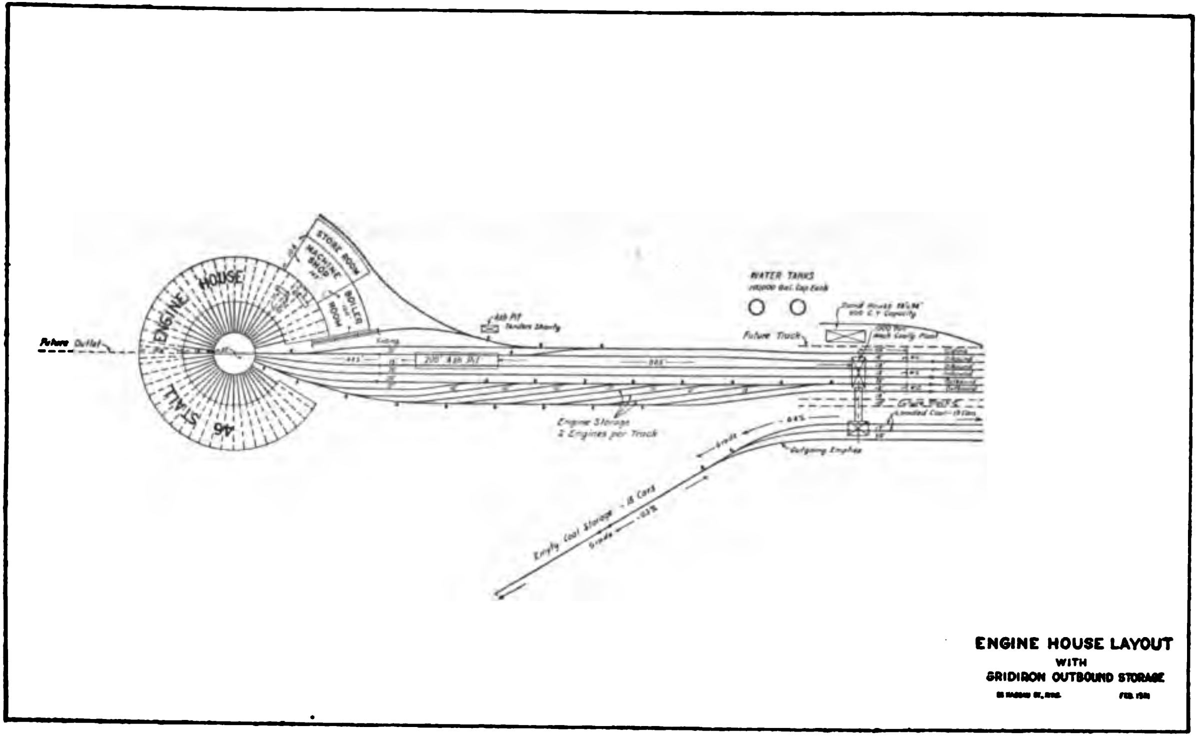


FIG. 9.—ENGINE HOUSE LAYOUT.

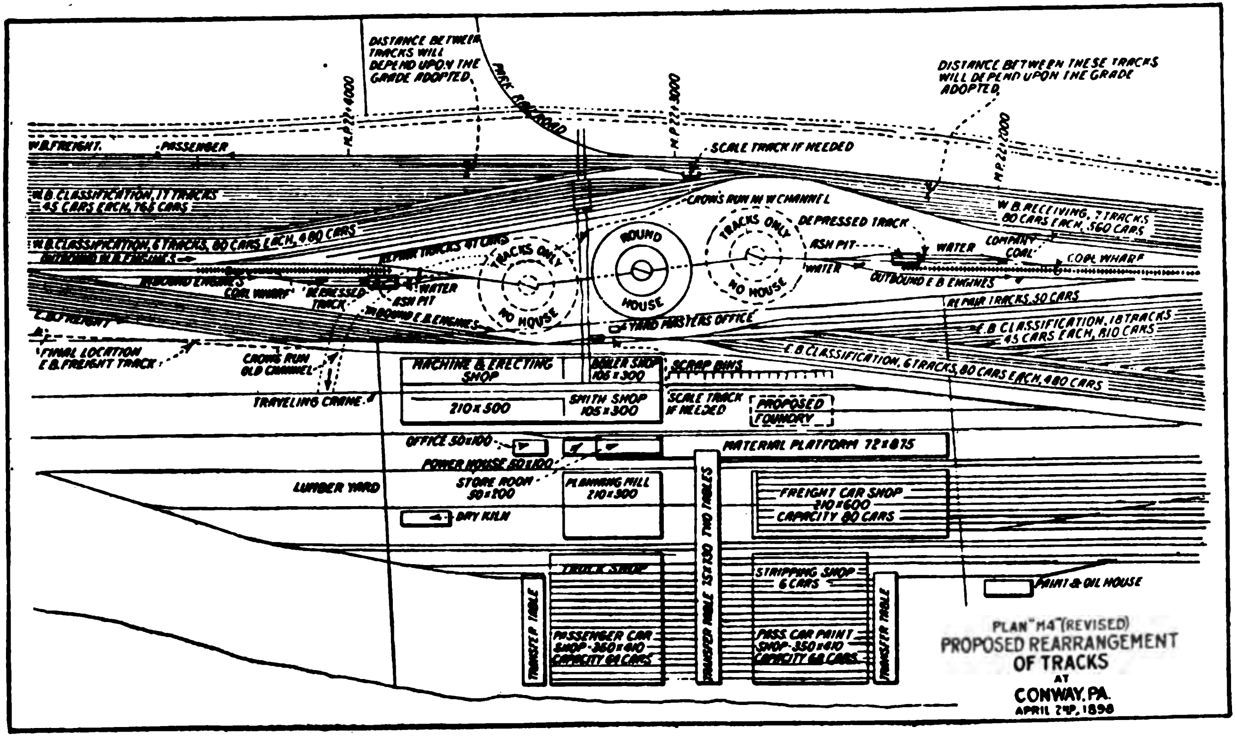


FIG. 10.—PROPOSED REARRANGEMENT OF TRACKS AT CONWAY, PA.

tipple should have steam pipes for thawing coal in pockets and in cars placed to be dumped. Much attention should be given to these facilities; the coal should be delivered promptly and a reasonable reserve insured, the sand and water supply convenient, and the ash pits ample, insuring both rapid cleaning of fires and disposition of cinders. Tools and supplies usually issued in the engine house may often be more conveniently issued to the engine from a small building near the ash pit. There should be standpipes on both the ingoing and outgoing tracks and standpipes for yard engines may also be provided at both ends of the yard.

40. (7) *Yard Office.*—While one general yard office must be maintained, two auxiliary yard offices may be justified. Warm, dry, and attractive quarters should be provided where yardmen may eat and change their clothes or keep special clothes for bad weather.

41. (8) *Car Repair Tracks.*—Frequently two car repair tracks will greatly help the car movement, as will two track scales.

42. (9) *Caboose Tracks.* — A caboose track should be placed at the end of both the eastbound and westbound yards and connected with the running tracks.

43. (10) *Track Scales.*—In "hump" yards the track scales are placed on the "hump," but in some yards they should be on a track connected with the running tracks.

44. (11) *"No-bill" Tracks.*—The receiving or classification yard should have tracks for handling "transfer" and "no-bill" cars.

45. (12) *"Hold" Tracks.*—The evils of the "hold" and the "special movement" are great. The car given a preferred movement, unless special provisions are made for handling, may cause as much trouble as a hundred cars systematically stored or normally moved.

46. (13) *Transfer Facilities for Connections:* (*a*) INTERCHANGE YARDS.—Approximately half the freight moved by a road is received from or delivered to connections, and this interchange consumes about 16.8 per cent of the life of the car. That is, of 2,241,755 freight cars in the equipment on

March 1, 1920, the equivalent of 376,615 were in the hands of the railroads and passing from one to another. It is very important, then, that facilities for this interchange be convenient and easily worked. The greater part of the delay is, of course, at the large terminals, though some of the simpler connections are wicked offenders. Under the inspiration of H. H. Porter, the Chicago Union Transfer Railway Company was organized on October 31, 1888. It purchased a tract of about 5000 acres and built the Chicago Clearing Yards on the "hump" plan. These yards were designed to handle 4000 cars per day in each direction. Applying the principle of the clearing house banks, originating in New York on October 4, 1853, these interchange yards were by far the largest and most complete installation in the country. They were adequate to handle all car load interchanges between the twenty-three railroads then entering Chicago. They fell into financial difficulties, perhaps because of their size and novelty, and finally passed into the ownership of twelve of the stronger companies, which are now operating them successfully. At this time (October, 1921) the yards have 184 tracks and capacity to handle 10,000 cars daily. Actually from 3,800 to 5,000 cars are handled per day. There are 37 riders in each shift, riding cars in both directions, returned by electric speeders and averaging 41 rides in eight hours. About five cars per minute are passed over the "humps." The average time in the yard per car is four hours. The underlying idea is so good that it is a matter of surprise that it has not been adopted in more modest form at many large railroad centers. There are few devices by which so much could be accomplished in the way of returns from economy and expedited movement.

47. (*b*) Belt Lines.—In most terminal studies the industrial or switching belt line presents a special appeal as an effective clearing agency, whether privately or publicly operated. In a large industrial district, diversified in character of freight, two principal arrangements stand out in contrast according as the competitive or joint policy is given precedence: (1) with industries generally aligned along the

rail facilities of particular carriers able to give especially convenient or direct service; (2) with industries distributed more or less freely as such factors as site, labor, housing, water supply, etc., dictate.

The latter cases imply a certain freedom of location absent in the former, and usually require some form of common switching service to and from carriers doing the road haul. In many cities this has seemed to be worked out best by forms of belt-line organization, varying widely as to details of ownership, administration, and operating methods. It seems quite certain that recent practice and experience is tending toward a recognition of the value of the belt line as one of the mechanical elements of a comprehensive district clearing system. The specific plan, of course, varies widely in different localities.

As a means for controlling and directing urban development along the rational lines of a wholesome city plan, the belt line appears to have been rather neglected. Of course, Chicago with its four concentric belt lines and New Orleans, Indianapolis, and San Francisco are examples to the contrary. But this is especially true in the smaller rapidly growing industrial centers. And here, if not in the older and larger cities, this feature of terminal organization might well receive further study and development.

48. (*c*) TRANSFER TRACKS.—Where transfers are made directly between roads over transfer tracks, the trackage should be ample for a day's movement and there should be a sufficient number of tracks to insure against conflicting movements.

49. (14) *Running Tracks.*—It is very important to insure prompt movement of road engines in the yards and for this purpose running tracks for light engines, which under no circumstances may be used for storage or yard switching, should be provided.

50. (15) *Wreck-train Track.*—The location of the track housing the wreck train is of importance, adapted both to rapid assembling of the wrecking crew and to insuring direct and unimpeded access to the main track.

51. (16) *Sub-classification "Gridiron" or Station-order-yard.*—A gridiron in which the number of tracks and the capacity of each track in cars should be the square root of the number of cars that a track in the classification yard will hold, is used to assemble the cars for the train in station order. A small shunting yard will serve the same purpose and is the method usually followed.

52. (17) *Storage Yard.*—When a blockade threatens, cars that cannot be forwarded should painstakingly be put away in the storage yard, from which it will subsequently be convenient to withdraw them and where they will not have to be rehandled daily or interfere with working the yard. Separate and full records should be kept of these cars and in storing them they should be classified as to destination, class of car, or lading.

53. (18) *Icing and Stock Pen Tracks.*—Icing plants and stock pens should be placed by themselves and not involved with the general yard movement. Trains using them should be kept intact and handled on separate sets of tracks arranged for that purpose.

54. (19) *Receiving Tracks.*—These tracks should be long enough to receive incoming trains without breaking up and sufficient in number to take them off the main track as fast as they arrive and contain them while held for sorting.

55. (20) *Classification Tracks.*—These tracks should be long enough so that trains may be made up for dispatching without "doubling over" and of sufficient number to provide one track for each train destination or each separate train service. The number may be reduced by the assignment of several tracks for trains to be re-switched in the sub-classification yard (16).

56. (21) *Departure Tracks.*—These tracks should be of sufficient length to hold departing trains ready for road movement and numerous enough to keep the classification yard free, notwithstanding ordinary delays in engine movement and crew, or train departures. There should be ample provision of air pipe lines for testing brakes.

57. (22) *Facilities for Properly Caring for Trains Passing through the Yard without Switching.*—I know of no yard

in this country where entirely independent provision is made by suitable arrangement of tracks, ash pits, coal and water supplies, to effect a change of locomotive and caboose, or where the locomotive and crew may be run through to a further terminal, without disturbing the make-up of the train or having it come in contact and interfere with the work of the classification yard.

In England, where in handling fast freights these changes are effected in five minutes, great care is taken with the necessary facilities. It would be quite possible, were we so equipped, to expedite greatly the movement of fast freight or to extend the engine runs, with all the consequent advantages. I used to run the passenger, fast freight and coke trains between Chicago and Crestline, 280 miles, as a continuous run, and the freight engines made 5000 miles and the passenger engines 8000 per month. I also ran for several months a passenger engine between Chicago and Pittsburgh, 468 miles, getting 14,000 miles a month each out of two engines.

58. (23) *Facilities for Trains Taking On or Setting Out Cuts Only.*—Where engines are changed, the relieved locomotive cuts off with its "set out" and the new locomotive couples on with its "fill out," and the time of movement is about the same as where locomotives alone are handled.

59. (24) *Facilities for Make-up of Trains to Be Switched at a Farther Point.*—The facilities described in Item 21 may be used for this purpose also, or similar but independent facilities may be provided.

60. (25) *Yard Leads.*—The main tracks should be kept free from switches except at the ends of the yard. Lead-in and lead-out tracks should be provided so that yard engines will not foul the main tracks. Where possible, they should run up to the next adjoining telegraph station.

The yard leads should be so arranged that the locomotive may be worked in the forward motion, and the necessity of the engineman turning around in his seat be avoided. Where yards already constructed make this necessary, the reverse lever may be moved to the left-hand side of the

locomotive and the engineer and fireman exchange their customary positions.

The angle of ladder tracks should be somewhat larger than the angle of the frogs, giving better alignment, increasing siding capacity, and gaining compactness in the location of the switches. The customary spacing of yard tracks is: between sidings, 13 feet; of ladders, 16 feet; of repair tracks, 19 feet. The minimum grade on which cars will run by gravity is 0.7 per cent. Not more than 15 tracks should be connected with a ladder. If more are necessary, use two ladders set V-shape.

In planning a yard all switch stands on ladders should be located on the side opposite the frogs and should have the lever throw parallel to the ladder. Tracks should as a rule be numbered and the numbers painted on the switch targets, odd or even in accordance with the time card designation of the trains into which cars are to be made up. Slip-switches and scissors, or double crossovers, can be used to save space, but they are hard to maintain, and judgment should be exercised in placing.

61. (26) *Yard Lighting.*—Yards should be well lighted to prevent accidents and theft and to facilitate work. Care should be taken in placing lights not to create dense shadows. The shades on electric lights should be adjusted to protect the line of vision of men riding cars.

62. (27) *Telegraph and Telephone Facilities.*—Telegraph and telephone facilities connecting telegraph offices, interlocking towers, engine houses, crew dispatching offices, yardmasters' offices, and offices of trainmasters and train dispatchers with each other, as well as with those of nearby yardmasters and station agents, should be ample and kept in first-class condition. Where there is much of this service a local telephone exchange should be operated.

63. (28) *Concentration of Facilities.*—The great engineering vice in yard layouts comes from feeling that economy is reflected when every foot of ground is covered by construction and undue regard for concentration of facilities, so contrary to the general practice around stations. The result

is a cramped yard, restricted and awkward for the men, and producing slow, conflicting and costly movements. On the other hand no opportunity should be neglected to reduce time and space in transportation movements. For this reason we are justified in resorting freely to the use of slip-switches, to combination switches and crossovers, to scissors, or double crossovers, and to the nesting of switch levers without interlocking as making possible a compact arrangement and greatly reducing distance.

The detention of cars in terminal movement absorbs 12.5 per cent of their life, or the equivalent of 280,219 cars, while delays in the movement between divisions in intermediate yards absorb 13.0 per cent of their life, or the equivalent of 291,428 cars. Because of the large surplus of equipment held by the railroads over long periods and the necessity of moving it through terminal yards to the storage yards, or handling it from time to time as it is found to be in the way, there is an absorption of cars of 4.8 per cent, or the equivalent of 107,604 cars, based on the equipment in the country on March 1, 1920.

While the large terminal handles the initial and final movement of cars loaded or unloaded there, it serves also as an intermediate yard for passing cars from one operating division to another. There are many intermediate yards where the latter constitutes almost all the work, there being practically no business handled save that of the railroad. But while there is little sharpness of definition in these terms, the distinction between the two classes of movement is very definite.

There remains to take account of cars interchanged between different roads. While some of this is over the single curved track connecting the lines at their crossing, or track arrangements but little more elaborate, by far the largest part is over belt roads or through terminal yards, and, as we have seen, this may grow to an importance warranting special and exclusive facilities, as those of the Chicago Union Transfer Railway Company. The detention of cars by this

movement involves 16.8 per cent of their life, or the equivvalent of 376,615 cars. And finally, while some car repairs are made at junction points and other outlying places, most of this work is done in car shops or on repair tracks at terminals. This cause of detention involves 8.9 per cent of their life, or the equivalent of 199,516 cars.

We have, then, an absorption of car life by the road movement and its delays of 11.4 per cent, by these four yard movements of 47.1 per cent, and by making repairs of 8.9 per cent, or a total of 67.4 per cent, or the equivalent of 1,510,942 cars.

It goes without saying that we have here a problem of the very first rank, one that can be resolved only by what the Lelands hold forth as the explanation of their success: (1) organization, (2) equipment—layout, plant and tools, and (3) knowing how.

The last is the most important. I recall once going out to clear up a mess and asking one of my people what was the cause of the trouble. "My God, Mr. Loree," he said, "they don't know how to do it." Fortunately we were able to show them. Undoubtedly the Lelands are right.

64. Faulty Yards.—How badly some of our yards were designed or have grown to be may be inferred from the following criticism of an intermediate terminal yard:

The yard is located at the summit of a hill, making it more difficult for the switching engines to switch uphill and causing them to take much smaller cuts. From the north end of the yard all switching is done on the main track, which runs in the main street of the town. The freight house is located on the west side of the north end of the yard, and all delivery cars must be switched in the street. The tracks are short, none holding a full train, compelling trains pulling into the yard to double over. Contrariwise, the outgoing trains must be made up on two tracks, resulting in delay in making couplings and pumping air. There are not sufficient tracks to permit of classification being made without much rehandling of the cars. The ice house is small and facilities for icing cars are poor. Only two cars can be iced at one time, necessitating the re-spotting of cars many times. The car repair yard is small, having but four tracks with a capacity of thirty-five cars, resulting in the standing of cripple cars on tracks that should be used for classification pur-

poses. The cinder pit track, which covers the coal chute and cripple tracks, is short, holding only three large or five small engines, and not infrequently there are as many as nineteen engines waiting to have fires cleaned, blocking both the coal chute and cripple track. The southbound yard is located about two miles south of the main yard on the double track. The ladder track leads directly off the main yard on the double track and the switching engines must remain idle when clearing first class trains. Movements from the ash pit track, coal chute track, and the sand house track, can only be made by crossing the cripple tracks and then running out on the main tracks. The only direct communication between the roundhouse and the north end of the yard is a track leading from stall No. 17 on the north side of the roundhouse. This track runs beside the storeroom and over the scales, is nearly always blocked with cars of company material waiting to be unloaded, or cars of coal for the stationary boilers, and movements can only be made over the track in an emergency after moving out these cars. The track should be relaid with heavy rail. The two tracks leading from the north end of the shop are used for the storing of coaches, steam being furnished for heating the same from the stationary boilers. These tracks cannot be used without first moving out these coaches, and the only other access to the shop is over the cripple tracks. The roundhouse, which must protect some eighty-seven engines and which handles daily about forty-five, needs to be provided with some long stalls for use by the large type of engines; at present they not being long enough to permit work on trucks of engines of this type. Seven men are employed to shovel ashes from the pit to the cinder car. Both time and money would be saved by the reconstruction of these pits and the use of a clam shell for lifting ashes. Engines are frequently stored in the roundhouse. In view of the fact that the engine house is already crowded, this practice is questionable. The yard handles about twenty first-class trains daily, with forty-five regular engine movements to and from the roundhouse, and these, with some fourteen other crew movements, involve about seventy-three engine movements. It would look as though the time lost by reason of bad facilities at this point amounts to about $8\frac{1}{2}$ engine hours for each working day. Possibly a more detailed examination will disclose other defects.

I do not quote this as a horrible example but as typical of many large terminals.

It is interesting to reflect that one main cause of the failure of the German military movements was inability to operate their railroads. When the Allies went into Metz,

there were more than twenty kilometers of yard tracks filled with military stores, on some of which grass was growing. Much of the success of the French operations was the effect of their "regulating stations," the terminal yards where the trains of military supplies were broken up and switched for delivery to the troops in the front line.

65. The Look Ahead.—I have a memorandum made in 1889 wherein one of the most efficient managers of that day said: "The growth of tonnage has been provided for by increasing the capacity of our cars and engines. However, we have reached that stage in the development of rolling stock which makes it clear that the bulk of the future growth must be taken care of as far as train movement is concerned by additional main-track."

I think no one to-day is likely to dogmatize on this or any other feature of railroading. No railroad indeed is finished while the trade for which it was constructed continues to grow; and progress is the genius of our people.

It is well to make up programmes on a basis of one, five, ten and twenty years, and then subject them to continuous study and revision. We may buy additional land with confidence; the purchase of too much equipment is soon overcome by the growth of business; on the other hand we hang back and postpone as long as possible work to increase facilities the use of which may be increased by ingenuity and method.

Do not let yourself be placed in the position of Little Helwig in the "Wild Duck," to whom her father brought back from the dinner not the promised sweetmeats but the bill of fare.

I would suggest that you buy and use as familiar tools: *Students' Standard Dictionary* (Funk & Wagnalls); *Economics of Railway Location,* by A. M. Wellington; and *Notes on Track,* by M. W. Camp.

But far more important than reading books is cultivation of powers of observation and study of men.

When only sixteen years old, George Washington went into the mountain wilderness of Western Virginia to spend three years in surveying the lands of Lord Fairfax. Before he was twenty-three he had been as far west as Piqua, Ohio, as far north as Lake Erie and had participated in the battles of Great Meadows, Fort Necessity and Braddocks Field. For six years he commanded the army of the Revolution, triumphing at Trenton and Monmouth, holding firmly the strategic position of Valley Forge through the dreadful winter of 1777-78. The mainspring of the war from the beginning, he received the sword of Cornwallis at Yorktown. He it was who brought about by the adoption of the Constitution, "an indissoluble union of the States under one federal head," and he has left us as well, in his "Farewell Address," counsel and advice to which we shall be wise to conform our future conduct.

General Sherman, who thought men entirely great to be very rare indeed, believed "Washington approached greatness as near as any mortal." Five days after his death John Marshall described his position in American history to be, let us hope it ever may remain, "first in peace, first in war, and first in the hearts of his countrymen."

Think on George Washington—a conscientious family man and efficient officer, a far-sighted statesman and a resolute executive. He belonged to the Corps of Engineers in politics as well as in war, and used his power to bring victory out of defeat, and order out of chaos.

PART II

SHOPS AND EQUIPMENT

The effect of discipline and drill is to concentrate, to make the whole mass a machine which, at the will of one, may exert its force in a certain direction and to a certain end.

It is character as a leader and the power of will that will enable one to control masses of men. These he must dominate and keep friendly by exercising the full powers of his personality. He must have not only courage and endurance but also that indefatigable quality called "pluck" and, as well, instinct, that incomprehensible something which takes the bird to its nest in the vast sameness of the prairie, or the bee to its home in the hollow tree hidden in the labyrinth of the forest.

The first step in education is to give a rule and guide to conduct, followed by training to concentrate, to observe, and to remember, and finally to subject all alike, himself included, to that discipline which is a bond stronger than iron; more impervious than adamant.

PART II

SHOPS AND EQUIPMENT

66. Car Repair Shops, Tracks, and Floating Gangs.—Not only should the car repair shop be of ample size, well lighted and heated, but it should be so placed as to avoid conflicting movements in placing and withdrawing cars. A good plan is to make it of such proportions that each shop track will hold as many cars as will occupy the repairmen a half day without interference; these tracks can be served by suitable connecting switching inlet tracks, transfer table or crane, and the outlet tracks connected with storage tracks of adequate capacity. Facilities for repairing steel, wooden, and composite cars should be provided. Both here and in the freight car repair yard all the labor-saving tools and appliances needed should be installed, a provision everywhere sadly neglected. The work handled is too important to be delayed by failure to provide adequate plant and equipment.

Further, a crew of skillful active men should be organized to make light repairs on air brake apparatus, draft rigging, safety appliances, to replace brasses and do like work on the tracks in the yard without withdrawing cars from service or requiring them to be switched.

Remember, the average car is held out of useful service for repairs 8.9 per cent of its life, or the equivalent each day of the withdrawal of 199,516 cars from the equipment of March 1, 1920.

67. Freight Cars.—In 1900 I was president of the American Railway Association and went to Paris at the head of a

committee of the International Railway Congress to extend to that body an invitation to hold its 1905 convention in Washington, of which invitation, with the help of our English colleagues, we secured the acceptance. As one of the reporters I read a paper on the "Economical Size of Goods Trucks or Capacity of Freight Cars," and as it contained the information as to the growth of the freight car in this country at that time available I reproduce it here.

Report on the Question of the Economical Size of Goods Trucks or Capacity of Freight Cars [1]

The builders of the first American railways followed the examples set by the engineers of the Old World in constructing the early roads, and the freight cars that were built to run over them were, as a matter of course, patterned after the "goods waggons" of Europe. They were only required to carry light loads over short distances, and did not leave the rails of the owners.

At that period the local streams furnished the power for grinding the wheat into flour within a few miles of where it was grown; native cattle, fed within easy driving distance of the home market, supplied the beef used; wood was the universal fuel even in the districts where coal existed; and the capacity of the freight cars was ample for the duty demanded of them.

With the rapid increase in the wealth of the country following the discovery of gold in California in 1849, there was a corresponding increase in railroad construction, which, checked for a time by the Civil War (1861–1865) was resumed with renewed energy after its close, and the enormous development of the country, following the railroad construction in the Great West, entirely changed the character of the traffic and called for new methods of handling it. Bands of iron and steel connected the Atlantic with the Pacific, and the Great Lakes with the Gulf of Mexico; the coal of Pennsylvania warmed the citizens of Massachusetts, whose bread was made from flour ground out by the water power of the Mississippi at Minneapolis, from wheat grown in the Dakotas, and whose beef,

[1] This question was formulated as follows: "Study of the most economical capacity of goods trucks or freight cars, taking into consideration first cost, operation, length of haul, character of traffic, bulk of consignments per truck or car, direction of traffic, etc."

slaughtered in Kansas City and Chicago, was brought to him in wheeled refrigerators.

This development in traffic was of course gradual. For a time the cars of one road were not allowed to run over the rails of another; special organizations were formed, which not only contracted for the through continuous movement of the commodities but also built and owned cars, which enabled the traffic to be moved without transfer over the separate railways forming the links in the great railway system of the country, and the small car ordinarily built for local traffic was found neither adequate nor economical for the carriage of freight over the vast range to be covered.

Increase in Capacity

The cars originally built had four wheels with a carrying capacity of about 7000 pounds. The capacity was gradually increased between 1850 and 1860, so that the "five ton" car, with four wheels, for coal, and the 10,000 pounds capacity car, with eight wheels, for merchandise, became common.

The Civil War compelled an increase in the carrying capacity of cars, and "double cars" with eight wheels were built to carry 20,000 pounds of coal, but 15,000 pounds was the maximum loading for the closed or merchandise car until after 1865. As there was a wonderful increase in the miles of railroad built between 1870 and 1875, so the increase in the freight car capacity was marked, as shown in the following table of the standard cars and their capacities in 1873:

Freight Car Capacities in 1873

Kind of Car	Light Weight, pounds	Capacity, pounds	Per Cent Capacity, Total Weight
Box car .... 8 wheels	18,700	28,000	59.94
Stock car .... 8 "	20,295	20,000	49.62
Gondola car .... 8 "	17,280	28,000	61.81
Coal car .... 8 "	17,350	30,000	63.36
" " .... 4 "	7,635	{ 10,000 12,000	56.82 61.22
Coal hopper, 1875 .. 8 "	18,750	37,000	66.37

The 40,000 pounds capacity car was introduced in 1876, the 50,000 pounds capacity car in 1883, and the 60,000 capacity car became a standard in 1885 for all classes of freight equipment on the principal roads. In 1895 the capacity was again increased by the building on the part of the Pennsylvania Lines West of Pittsburgh of a large number of 70,000 pounds capacity self-clearing cars for the Lake coal and ore trade; the forerunner of the 100,000 pounds capacity steel car, built on the same general lines, and which is now the recognized standard car for this class of traffic. A number of 80,000 pounds capacity box cars were built in the same year, and some 100,000 pounds capacity are now under construction, and as these modern cars are permitted to carry a weight 10 per cent above the marked capacity, while the cars of early construction were restricted to actual capacity, the progress which has been made is even greater than the figures given would indicate.

The following table showing the relative changes in increase of dead weight and paying load, and the percentage of each to the total loaded weight, prepared by the New York Railroad Club in 1896, and supplemented by subsequent data, is of interest in this connection:

RELATIVE INCREASE OF PAYING LOAD WITH CAR WEIGHT

Year	Dead Weight of Car, pounds	Weight of Paying Load, pounds	Total Weight Loaded, pounds	Per Cent of Total	
				Weight of Car	Paying Load
1876	20,500	20,000	20,500	53.62	42.38
1882	24,000	40,000	64,000	37.50	62.50
1889	27,700	60,000	87,700	31.59	68.41
1895	36,000	80,000	116,000	31.04	68.96
1898	38,500	100,000	138,500	27.80	72.20
		110,000	148,500	25.93	74.07

Cars in the United States

The following statement shows the number of freight cars belonging to the various railroads, and the number of cars owned by individuals and companies, in the United States on June 30, 1898. These railroads had an aggregate mileage of line of 184,894 miles, and of second track and sidings of 60,345 miles, or a total of 245,239 miles of track:

NUMBER AND OWNERSHIP OF FREIGHT CARS, U. S., 1898 [1]

Kind of Cars	Owned by		Total
	Railroads	Individuals	
Box and refrigerator	615,159	66,270	681,429
Stock	57,052	22,747	79,799
Gondola	448,045	12,106	460,151
Flat	94,460	1,369	95,829
Miscellaneous tanks, 4-wheel coal, etc	63,473	12,548	76,021
Total	1,278,189	115,040	1,393,229

The house or closed merchandise cars were 54.76 per cent and the open cars 45.24 per cent of the total equipment.

Large Cars

Large cars may be defined as those exceeding the normal conditions, either as to dimensions or in carrying capacity, and for the purpose of this discussion are those exceeding 36 feet in length or over 60,000 pounds capacity, and are owned as follows:

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[1] Similar figures for December 31, 1918, are as follows:

NUMBER AND OWNERSHIP OF FREIGHT CARS, UNITED STATES, 1918

Kind of Cars.	Owned by		Total
	Railroads	Individuals	
Box	1,047,411	1,079	1,048,490
Refrigerator	63,066	55,124	118,190
Stock	88,607	2,474	91,081
Coal	964,763	19,269	984,032
Flat	126,474	669	127,143
Miscellaneous	107,622	102,125	209,747
Total	2,397,943	180,740	2,578,683

The house or closed merchandise cars were 52.25 per cent and the open cars 47.75 per cent of the total equipment.

NUMBER AND OWNERSHIP OF LARGE CARS

Kind of Cars	Owned by				Total
	Railroads		Individuals		
	Over 36 Feet	Over 60,000 Pounds Capacity	Over 36 Feet	Over 60,000 Pounds Capacity	
Box, common	2,420	200	1,410	......	4,030
Furniture	16,845	......	129	......	16,974
Gondola	637	4,952	......	......	5,589
Flat	1,442	110	......	1	1,553
Stock	148	......	691	......	839
Total	21,492	5,262	2,230	1	28,985

Cars of Large Dimensions

The large-dimension cars (those over 36 feet in length) were called into service by the action of the officers in charge of traffic matters placing certain articles in a classification that carried with it too high a rate and then fixing a minimum weight for a carload at a figure that could not be loaded in an ordinary car, and the "furniture car" was built to "beat the rule," and as a consequence articles that had been shipped "knocked down" were set up at the factory and shipped in these large cars, which grew in size as competition increased.

As an example of the light and bulky articles for which railroad companies are being asked to furnish cars I would cite "grain cradles." The official classification minimum for these is 20,000 pounds (5th class) and it would require a car 300 feet long to carry the minimum weight. The larger the car the more grain cradles can be loaded, and the less the charge for transportation; consequently, increased pressure is brought to bear on the railroads to increase the dimensions of their cars. This same principle applies to all light and bulky articles, constituting 430 of the 2700 articles for which carload rates are provided in the official classification.[1]

Such cars of abnormal dimensions are not only unwieldly but, with their lower floor plane, to some extent dangerous, and are unprofitable for the railways. Three hundred and fourteen furniture cars of 60,000 pounds capacity handled over one division in November, 1898, had loads averaging only 25 per cent of the marked capacity.

[1] In the Consolidated Classification, effective December 30, 1919, these have been increased to 1,643 light and bulky articles out of a total of 4,916 articles for which carload rates are provided.

A committee from the American Railway Association is now endeavoring to fix upon extreme dimension limits for closed merchandise or box cars and it is thought that by concerted action of the traffic and transportation departments of the lines the building of the special furniture cars will be stopped. The great railways are being compelled under existing transportation conditions to sink their individuality so far as freight cars are concerned, and must build cars that will pass freely from one section of the country to another and from one line of railway to another, and the height and width are limited, not by theory, but by the physical limitations of clearance of important railroads.

There is some question as to the relative economies to be effected by the building of closed merchandise cars of a greater capacity than 60,000 pounds. The following table shows the relative weight, capacities, and cost of the 60,000 pounds capacity and the 80,000 pounds capacity box cars, of which a large number are now being built by the Pennsylvania, Illinois Central and other lines:

Relative Weight, Capacities and Cost of Box Cars

Marked Capacity in pounds	Length, Feet	Paying Load, pounds	Body, pounds	Weight Trucks, pounds	Total, pounds	Pounds Paying Load Carried Each Pound Dead Load	Cost of Car	Cost per Ton Carrying Capacity
60,000	34	66,000	19,920	12,280	33,200	2.05	$556.35	$16.86
80,000	34	88,000	20,506	14,694	35,200	2.50	$603.95	$13.73

This shows a difference of $47.60 in the cost of the two cars, but the 80,000 pounds capacity car costs 18.6 per cent less per pound of carrying capacity than the 60,000 pounds capacity car.

It is objected that the greater light weight means greater cost of moving the car, but if we analyze the cost of moving the 3000 pounds greater weight, we have:

Average mileage of box cars per year	10,000 miles
" weight of box cars	16 tons
" " of paying load	10 tons
" cost of transporting paying load per ton mile.	4 mills
Cost of moving car and lading per mile	40 mills
40 mills divided by 26	1.54 mills per ton
1½ tons additional dead weight, 10,000 miles	15,000 ton miles

15,000 ton miles×1.54 mills=$23.10, cost per year to haul the additional dead weight.

If we assume an average receipt per ton mile of 5.36 mills and the cost as above at 1.54 mills, the net revenue from any additional freight hauled in such car would be 3.82 mills per ton mile, and to pay for the cost of moving the extra dead weight we must carry 6000 tons of paying load, \$23.10—3.83 mills, and as an 80,000 pounds capacity car will load at least seven tons more than a 60,000 pounds capacity car, one trip of 857 miles (6000 ÷ 7) each year, with additional load, would compensate for hauling the extra dead weight of 1½ tons the entire year.

As a matter of fact these cars can be and have been loaded with 88,000 pounds of grain at the elevators on the Mississippi River and carried to Baltimore, Philadelphia and New York. The capacity of the yards and terminals is increased by the use of such a car 33⅓ per cent over 60,000 pounds capacity car. Trade rules at the large commercial centers may have to be changed to enable the full utilization of such cars, but this will be done or the grain trade will pass around such centers.

Cars of Large Capacity

The large car, from a weight carrying standpoint, seems every way desirable for many lines that have special traffic, such as ore, coal, stone, brick and metal, where the cars can be made to carry full load in at least one direction. Every railroad of importance in the United States has spent large sums of money in reducing grades, improving alignment, and remodeling yards. The weights of locomotives are being constantly increased, and to get the greatest earning power from these locomotives and to secure the benefit of the large sums expended in improvements of road, it is necessary to have cars that will carry the greatest possible load without increasing the length.

There is a very large tonnage of ore and coal handled between the Great Lakes and the furnaces and mines located 150 to 200 miles distant therefrom. The ore is brought from Lake Superior region in vessels and transported from the various ports of Lake Erie to the furnaces, from 50 per cent to 60 per cent being forwarded direct in cars from the vessels to the furnaces without first being stored at the docks. These vessels a few years ago were of a maximum capacity of from 2500 to 3000 tons; now they carry as high as 8500 tons. A quick dispatch is required on the part of the vessel owner which under conditions prevailing five years ago would be impossible, but by the use of the 100,000 pounds capacity car it has been accomplished, and the railroad companies are handling a much heavier tonnage over the same tracks, and notwithstanding the earnings per ton mile have been greatly cut down they have been able to maintain a margin of profit.

A careful record taken of nearly 200,000 cars handled on two lines of railway leading from Pittsburgh to two of the principal ports of Lake Erie shows that it was possible to secure the following loads for their cars:

Ore									108% of marked capacity
Coal									82% " "
3,616 of the 100,000	pounds	capacity	cars	showed	an	average	loading	of	93%
136 of the 80,000	"	"	"	"	"	"	"	"	91%
6,727 of the 70,000	"	"	"	"	"	"	"	"	97%

Thus proving most conclusively that it was true economy under such conditions to build cars of greater capacity than 60,000 pounds.

The advantages gained by reducing the length of train for a given tonnage, which are secured by the use of large capacity cars, are:

1. That the friction and atmospheric resistance are lessened, and by bringing the moving load closer to the locomotive it can be handled with greater ease. The increase in the tonnage by the decrease in the number of cars is shown graphically by Figure 12.

2. A less number of cars and locomotives is required to move a given tonnage, saving interest on capital and car service, and lessening the empty car movement in the direction contrary to the heavy traffic movement.

3. The necessity of increasing the capacity of the main lines, freight yards, and shops is avoided, and at the same time the cost of switching is reduced.

4. A large saving in wages results from the decreased number of trains.

It is largely by these means that the railways have been able to reduce the cost per ton mile to a figure thought to be impossible several years ago.

So marked have been the economies resulting from the use of the large car that within the last twenty-five years there has been an almost complete rebuilding of the equipment. On March 1, 1920, of 2,241,755 cars listed, no more than 41,896 cars were below 60,000 pounds capacity and only 593,838 below 80,000 pounds capacity. Within a few years this small remainder will be entirely eliminated. But powerful as has been their influence in reducing capital investment in yard, track and depot facilities, movement, cost, etc., their influence on industrial development has been quite as marked. The building of our great blast furnaces and similar plants with their compact arrangement of buildings and other structures is dependent upon the large car, and

even in the small industries, local coal yards, etc., their influence is apparent.

The following statement shows the revenue freight cars owned by Class I roads, in service on March 1, 1920, and indicates the extent to which the freight equipment of the country has been converted into large capacity cars:

CAPACITY OF REVENUE FREIGHT CARS, 1920 [1]

Capacity, pounds	Box	Open	Other	Total
Below 10,000	....	......	....	......
10,000 and below 20,000	....	20	....	20
20,000 and below 30,000	13	113	2	128
30,000 and below 40,000	62	154	17	233
40,000 and below 50,000	3,025	3,184	5,000	11,209
50,000 and below 60,000	12,703	10,630	6,973	30,306
60,000 and below 70,000	375,192	68,966	71,280	515,438
70,000 and below 80,000	15,864	13,336	7,304	36,504
80,000 and below 90,000	442,825	241,335	36,559	720,719
90,000 and below 100,000	....	2,675	5,622	8,297
100,000 and below 110,000	136,651	552,638	6,524	695,813
110,000 and below 120,000	....	170,416	....	170,416
120,000 and below 130,000	....	897	....	897
130,000 and below 140,000	....	312	....	312
140,000 and below 150,000	....	49,506	....	49,506
150,000 and below 160,000	....	178	....	178
160,000 and below 170,000	....	......	....	......
170,000 and below 180,000	....	1	....	1
180,000 and below 190,000	....	2	....	2
190,000 and below 200,000	....	......	....	......
200,000 and below 210,000	....	1,761	....	1,761
210,000 and upwards	....	15	....	15
Total	986,335	1,116,139	139,281	2,241,755

[1] "Open" cars include all open top cars such as gondolas, hoppers, flat, etc. "Other" cars include such cars as stock, refrigerator, tank, etc., not classified by the I. C. C. as open or box cars. Data compiled from the Official Railway Equipment Register, March, 1920.

68. The Present Status.—Great improvements have been made in the details of construction of freight cars, and while some things still remain to be done the latest examples are, on the whole, satisfactory vehicles.

The chilled cast-iron disk wheels long remained the most economical wheels ever placed under a car. When made of a proper mixture of pig iron and with the best foundry practice, they give safe and durable performance under cars of from 60,000 to 140,000 pounds capacity. Varieties of rolled-

pressed-steel wheels, and of forged-steel wheels are in use under cars of the heavier types.

The brake apparatus admits of convenient and accurate adjustment and the old method of hand operation by means

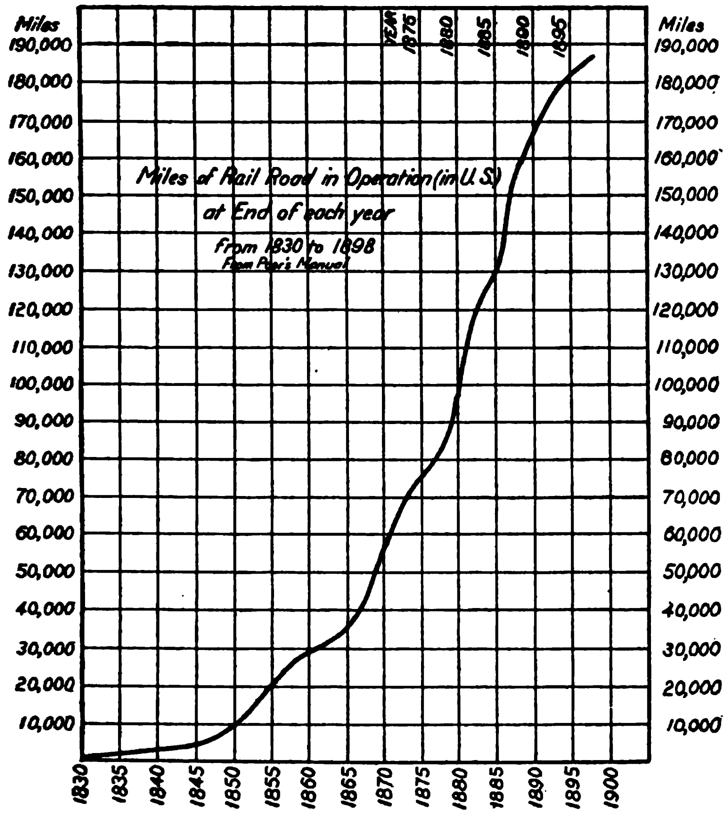

FIG. 11.—MILES OF RAILROAD IN OPERATION.

of a so-called brake wheel is being supplanted by an improved drop handle design which can be operated by one hand, thereby permitting the brakeman, while standing on both feet, to maintain a firm hold upon the grab-iron of the car with his left hand. This improved method of operating hand brakes presents many advantages as compared with

the old hand wheel brake which was usually operated with a club. The operating parts of the improved brake, includ-

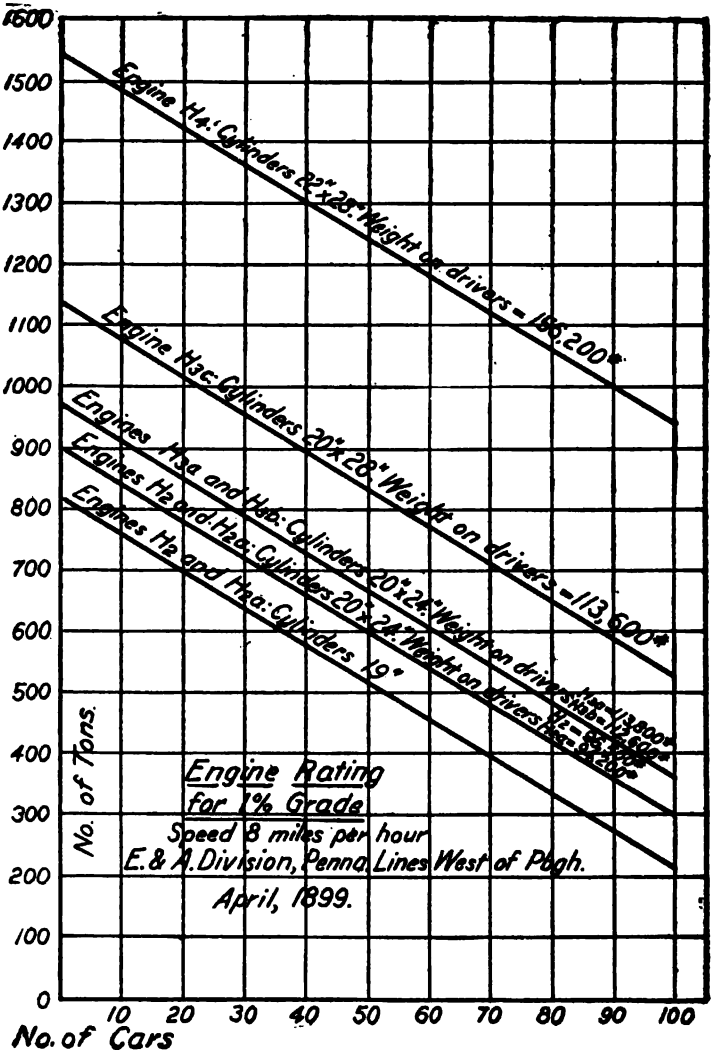

FIG. 12.—ENGINE RATING FOR ONE PER CENT GRADE.

ing the pawl, are fully enclosed in a casing which prevents sleet, cinders, snow and other material from interfering with

operation in cold weather. The "empty and load" air brake appliance establishes a closer relation between braking power and work to be performed. It will prove of greater value as the spread between the weights of the empty and loaded car is increased.

The arch-bar truck was an essential type in the early days of railroading when most track was in what we would now deem impossibly bad surface, and when much depended upon it to accommodate the movement of the truck thereto. With the modern heavy car trouble resulted from frequent breakage and difficulty of maintenance. While this was due to faulty processes and carelessness in manufacture rather than to type, the arch-bar truck does suffer from being an assembled structure.

The effort to introduce the more expensive steel casting side frames led to many derailments and failures. Either the arch-bar side frame or the steel casting integral side frame may be designed of ample strength. The effort should be to use in both the same journal boxes, springs, and brake attachments, and to have all limiting dimensions identical. The swing hanger type of truck was formerly relied on to compensate for track inequalities, and the good points which it embodies brought it into extensive use some years ago, but of late the rigid type of freight truck has largely supplanted the swing motion style, except for passenger equipment.

The use of anti-friction side bearings to reduce train resistance is a generally accepted principle in the design of modern equipment. The type having a polygonal roller rocker, designed so that the top and bottom bearing faces of the rocker travel in true parallel planes, apparently solves the problem of securing efficiency and durability.

The introduction of steel sills has eliminated many of the problems of the old design of floor frame. The early designs of steel underframes proved entirely too light. Thousands of cars built before 1910 had a maximum cross-sectional area of no more than fifteen square inches in the center sills, and this, with the light body bolster, led to frequent breakings. In 1913 the Master Car Builders'

Association recommended a minimum cross-sectional area of sixteen square inches, and later in the same year twenty square inches. In 1920 they again raised this to thirty square inches. Many of these old cars were strengthened by applying cover-plates on the flanges of sills and reinforcing plates on the webs of sills. While, of course, the tare weight should be kept at the minimum, the condition of freight car equipment, its cost of maintenance, and the loss of per diem use indicate clearly the errors made in the endeavor to reduce both weight and first cost. It would seem that many parts could be strengthened by increasing weight, with great advantage both to maintenance and utilization.

With the introduction of cars of greater capacity and locomotives of greater tractive power, the old light cars are frequently damaged; the consequent danger, expense, and delay are forcing their rapid reconstruction or elimination.

The automatic coupling device now in use has eliminated one of the most prolific causes of personal injuries. The Master Car Builders' Association has now but one approved standard coupler, felt to be heavy enough and strong enough to take care of the most severe service, insure safety, and prevent break-in-twos.

There is, however, a very general failure to appreciate the problems involved in the draft appliance back of the coupler to which it it attached. Not only does it secure one car to another, but it must absorb the impact due to movement of locomotive or cars, and transmit the shock gradually and equally to the center sills and delay the full effect of the blow until the car to which it is attached can, by its own movement, relieve the pressure. Conditions have been further changed by the introduction of steel cars. In former years the wooden cars furnished a great amount of train flexibility on account of the resilience of the wooden sills, but the steel cars, with very rigid center sills, have greatly reduced this flexibility. Again, the tremendous impact of cars running practically wild in "hump" drilling has raised problems not yet satisfactorily disposed of. Decidedly it

here does not pay to save in first cost at the expense of maintenance. It is most important to use the most powerful gears, the movement of which is controlled by friction or otherwise, made of the best material and properly designed to secure durability and ease of maintenance, to protect the car and its lading both in trains and in classification yards.

The framework of the superstructure is now largely standardized, though some designs seem much lighter and cheaper than others in general use. There are in the market satisfactory box car ends which materially strengthen the body and add durability. Much still remains to be done in developing satisfactory roof construction.

The "plain" or "bare" car consists of some 13 assembled parts essential in all construction. The price of the "bare car" may be taken as uniform for the type for the per pound weight. For gondolas during the five years 1910–1914, it was 2.2 cents per pound. What used to be called "specialties," and are better described as "accessories," consist of some 18 additional assembled parts and add about 11 per cent to the cost of gondolas. These "accessories" consist of couplers, draft springs and gear, journal boxes, side bearings, etc. There must also be added cost of engineering, inspection, and freight from the car builders' plant to the purchasing road. To the average prices above, about 147 per cent should be added to give the price of 1918, and since then there have been further substantial increases.

Figure 13 gives an analysis of cost, number of pieces and cost of repairs of a typical hopper gondola car.

The freight car and its multitudinous parts have been constantly the subject of attention by the officers of the maintenance of equipment department as individuals and in their organized capacity.

The Master Car Builders' Association was first suggested by Leander Garey, master car builder of the New York Central, who as early as 1864 had at intervals called informal meetings of the master car builders of a few of the nearby roads. The Association was formally organized at Altoona,

FIG. 13.—ANALYSIS OF ORIGINAL COST AND TOTAL NUMBER OF PIECES, TOGETHER WITH COST OF LIGHT AND HEAVY REPAIRS FOR A GONDOLA CAR

Main Division	Original Cost, Per Cent [1]	Parts [2]	Number of Pieces: Principal Pieces	Number of Pieces: Bolts, Nuts, Rivets, Studs, Pins, etc.	Number of Pieces: Total	Cost of Light Repairs, Per Cent [3]	Cost of Heavy Repairs, Per Cent [4]
Truck	33.06	(1) Side frame	66	....	....	21.3	7.9
		(2) Axles and wheels	12	....	....	29.6	4.9
		(3) Bolster	12	....	....	1.7	1.8
		(4) Part of brake rigging	62	....	....	1.9	5.9
		Total	152	132	284	54.5	20.5
Underframe	43.24	(1) Center, side and end sills	51	....	....	0.8	13.1
		(2) Body bolster	14	....	....	4.4	2.0
		(3) Diaphragm	20	....	....	0.0	1.1
		(4) Draft rigging	54	....	....	26.1	16.7
		(5) Part of brake rigging	47	....	....	4.1	3.0
		Total	186	1246	1432	35.4	35.9
Superstructure	23.70	(1) Side and end posts, braces and plates	84	....	....	1.5	3.6
		(2) Side boards	60	....	....	2.6	17.3
		(3) Ladders	33	....	....	1.3	1.3
		(4) Floor	64	....	....	1.8	17.7
		(5) Drop doors	58	....	....	2.9	3.7
		Total	299	668	967	10.1	43.6
Total	100.00		637	2046	2683	100.0	100.0

[1] Information is based on U. S. R. R. A. 50-ton composite gondola, with arch-bar type of truck.

[2] Information is based on U. S. R. R. A. truck and underframe and superstructure of D. & H. 37,000 series, 42½-ton double-door gondolas.

[3] Information is based on repairs to 528 cars in D. & H. shops at Colonie, N. Y., involving total cost of material of $2,998.34, and of labor $523.43, being 85.1 per cent and 14.9 per cent respectively, and totaling $3,521.77. It will be noted that repairs to side frame, axles and wheel and draft rigging absorb 77 per cent of the total.

[4] Information is based on repairs to 500 cars in D. & H. shops at Colonie, N. Y., involving total cost of material of $79,297.27, and of labor $29,424.38, being 72.9 per cent and 27.1 per cent respectively, and totaling $108,721.65. It will be noted that repairs to center, side and end sills draft rigging, side boards and floors absorb nearly 65 per cent of the total.

Pa., on September 18, 1867, and had for its purpose the advancement of knowledge of the construction, maintenance, and service of railroad cars and their parts by investigation and discussion in convention, the provision of an organization through which the members could agree upon such just action as might be required to bring about uniformity and interchangeability in the parts of railroad cars; and to improve their construction and adjust mutual interests growing out of their interchange and repair. Through its committees and conventions, officers in charge of car repairs and construction were brought together, ideas interchanged and steps taken toward the adoption of various standards.

The interchange rules were designed to secure the compulsory adoption by car owners of detailed standards. Cars not conforming to these standards were not permitted to be interchanged and this rapidly brought about the universal adoption of such as standard axles, couplers, air brakes, brake beams, wheels, air hose, etc.

One of the outstanding faults of standardization is the check it puts on development. Fortunately, the difference in demands in various parts of the country and different industries has prevented the adoption of any complete design. End-door openings, wide side-door openings, open-top cars with hopper bottoms and with flat bottoms, drop ends, etc., stimulated advances to meet special requirements. But this has not interfered with the standardization of practically every detail that ordinarily wears out or becomes defective and requires renewal in service (trucks and running gear, couplers, underframes, and other details); so that now these parts are interchangeable and repairs can be made promptly without waiting for material from the car owner and without holding the car out of revenue service or unduly delaying it, and the quantities of repair parts carried in stock have been reduced.

As an indication of what has been accomplished in the standardization of parts, the following comparison is representative:

	1882	1921
Different kinds of axles	56	6
" " " journal boxes	58	6
" " " couplers	26	1
" " " brake shoes	20	1
" " " brake heads	27	1

Even more important than the attention given to standardization has been that given to the development of special appliances, notably the automatic coupler, and the constant improvement in the vehicle in its capacity, strength and economy of construction, maintenance, and adaptability to service demands.

69. Provision of Cars.—One of the prime difficulties in car supply is that no authoritative voice has said what the responsibility of the several roads is for furnishing the cars necessary for the movement of traffic. Shall the line originating the business furnish all the cars for its movement or shall the intermediate and distributing lines participate on the basis of their proportions of the gross earnings or the ton miles produced? Shall a considerable number of lines remain year in and year out as per diem debtor lines or borrowers, or shall all lines be expected to provide themselves with equipment adequate to equalize these charges? Until the American Railway Association, the Association of Railway Executives, or the Interstate Commerce Commission establishes the obligations of the respective carriers under such conditions not even a beginning can be made toward a satisfactory solution.

Equally important is the definition of the duty the carriers owe the traders in moving the peak of the load. Much railroad traffic is seasonal and normally the greatest demand for movement occurs about the tenth of October, whereas the bottom of the slack season occurs about the first of June. The average difference between the two over a period of twelve years was 118,940 cars. This condition is sharply reflected in the money markets of the United States, in the typical June the gross burden being about 13 per cent lighter than in the typical October. Where does

the responsibility lie as between the two parties? Must the carriers to protect the peak provide 118,940 cars that must be more or less idle the balance of the year, or should the traders provide themselves with such elevators, warehouses and other storage facilities as would more evenly distribute the movement?

Closely related also is the problem of movement in periods of high speculation or sudden demands due to varying, and for the most part local, causes, such as the recent excitement regarding the coal movement growing out of the withdrawal of coastwise shipping from the New England coal trade, a small but very disturbing trans-ocean export demand, and the desire to escape the increase in freight charges of August 26, 1920. What equity is there in calling on the railroads for an on-the-day movement under such conditions? As an instance of the way the railroads allow the traders to "tell the story" to their detriment, the coal operators raised the rating of their mine production capacity for 1920 over 1919, and merely by use of the lead pencil exaggerated the apparent default of the carriers. The roads should have, and, when necessary, should place before the public and the public's officers, their own estimates of the producing and shipping capacity of the traders.

As a matter of fact, no industrial organization in the country came within seeing distance of the railroads in meeting all demands during the last few trying years. If a railroad wished to buy freight cars it could get them perhaps a year after placing the order, or rails eight months after, but the cars actually unloaded each day by the traders, if supplemented by those the traders failed to unload because of their own lack of facilities, would always take care of the loads of the next day, and delays in shipments were slight indeed. I recall that Mr. McCrea said to his transportation officers, in September, 1900:

> We have had a tremendous boom; and we are now getting down to what I hope will prove more normal conditions . . . I do not believe that any other business of the country was handled so well during the boom as was the railroad business. Everything to be

moved was moved and with reasonable promptitude. Take the car supply for instance. Taking the United States as a whole, the empties of two days supply would have cared for all the business there was. The business, I feel, was handled most admirably and without congestion and showed the condition of the railroads to be much better than I think was generally believed. I did not believe that our lines could handle the business so well and so creditably as they did, and I believe that what holds good with our lines holds good over the country.

So far as there was disappointment in the railroad movement in 1920 it was not due so much to lack of cars, equipment, or even of facilities, but to the condition of the roads when returned by the United States Railroad Administration, to failure in the human equation, to sporadic strikes at points that were critical, and to the merchandising practices of the traders.

The chief difference between the situation of 1920 and 1900 is that in 1920 certain politicians sought to make it a source of political advantage and certain labor leaders a source of personal and organization advantage.

The freight equipment includes a great variety of cars and care has always to be exercised to keep it in balance with the traffic demand. It would be distinctly helpful if once each year the American Railway Association, Railway Equipment Guide, or some other agency were to publish a comprehensive review of the situation.

Just now the expulsion of the packers from the business of transporting fruits and vegetables by the Department of Justice has forced some carriers into joint ownership of refrigerator and heater car express lines. It is likely that these jointly owned facilities covering special fields may expand further for they promise economy and better service as well as better understanding between the roads.

One would think that on the question of the adequacy of car equipment, concerning which the railroads have borne so much public criticism, complete and accurate information would be at hand. Were each road to furnish in its annual report a statement of its freight car equipment as shown on Figure 14, complete data could be assembled and presented

FIG. 14.—INVENTORY OF STEAM RAILWAY ROLLING STOCK

INVENTORY OF STEAM RAILWAY LOCOMOTIVES

	Classification		Total			
Item	Type	Tractive Power in Pounds	Number	Tractive Power in Tons	Weight on Drivers in Tons	Weight of Engine and Tender in Working Order in Tons
1	Passenger, steam	20,000 or less				
2	Passenger, steam	Over 20,000				
3	Passenger, steam	All				
4	Freight, steam	40,000 or less				
5	Freight, steam	80,000 or less				
6	Freight, steam	Over 80,000				
7	Freight, steam	All				
8	Switch and work, steam	20,000 or less				
9	Switch and work, steam	40,000 or less				
10	Switch and work, steam	Over 40,000				
11	Switch and work, steam	All				
12	All steam	All				
13	Passenger, electric	All				
14	Freight, electric	All				
15	Switch and work, electric	All				
16	All electric	All				
17	Grand total	All				
18	Average combined passenger and ton miles per annum per pound of locomotive tractive power owned					

INVENTORY OF STEAM RAILWAY FREIGHT TRAIN CARS

Item	Type	Classification										Total	
		Number of Cars of Marked Capacity in Pounds						Number of Cars and Type of Construction				Light Weight in Tons	Marked Carrying Capacity in Tons
		Less than 60,000	60,000 to 80,000	80,000 to 100,000	100,000 to 140,000	140,000 and Over	Total	All Wood	Steel Underframe	All Steel	Total		
1	Box												
2	Stock												
3	Refrigerator												
4	Tank												
5	All closed												
6	Gondola												
7	Hopper												
8	Flat												
9	All open												
10	All other												
11	Grand total												
12	Average freight ton miles per annum per ton of freight car carrying capacity owned												

INVENTORY OF STEAM RAILWAY PASSENGER TRAIN CARS

Classification			Total						
Item	Type	Length Over Body and Sills in Feet	Number				Carrying Capacity		Light Weight in Working Order, Tons
			All Wood	Steel Under-frame	All Steel	Total	Number of Passengers	Tons of Commodities	
1	Coach or chair—first class	Less than 60 feet							
2	Coach or chair—first class	Over 60 feet							
3	Coach or chair—second class and emigrant	All							
4	Coach or chair and combination	All							
5	Parlor	All							
6	Sleeping	All							
7	Dining	All							
8	Business	All							
9	All passenger carrying	All							
10	Postal, express and baggage	Less than 60 feet							
11	Postal, express and baggage	Over 60 feet							
12	Miscellaneous	All							
13	All commodity carrying	All							
14	Total	All							
15	Passenger motor	All							
16	Commodity motor	All							
17	Total motor	All							
18	Grand total	All							
19	Average passenger train car miles per annum per car owned								

in a variety of forms. As it is now we are continually confronted to our discredit with comparisons of the ratio of growth of ton mileage and the ratio of growth of the number of freight cars, whereas the ratio of growth of tonnage carrying capacity of the cars, which is an adequate answer, is entirely ignored. While the information as to freight cars can, in the main, be compiled from statistics to be found in the Official Railway Equipment Register, information as to tractive power of locomotives and seating capacity of passenger cars is practically unobtainable, and it would be a great convenience if the various roads would publish in their annual reports the information called for in Figure 14.

The freight car stock of the country on December 31, 1920, was as follows:

FREIGHT CAR STOCK IN THE UNITED STATES, 1920

Kind	Number
Box cars	1,048,762
Flat cars	104,983
Stock cars	80,774
Coal cars	932,986
Tank cars	10,380
Refrigerator cars	59,677
Other freight cars	83,955
Total	2,321,517

70. Engine House.—Rapid increase in the size of locomotives has made most roundhouses obsolete, and this is the more regrettable as many were carefully built in what was intended to be permanent form. My own practice has been to run the concrete foundation up as a wall to the window sill and to use a gravel-covered wooden roof on wooden posts, broken in two offsetting slopes for lighting, ventilation, and disposal of rainfall. With a fire wall for each eight stalls this gives reasonable protection against fire hazard, is readily extended, and occasions no heartbreak if it has to be torn down. I once, at the request of the federal government, took the Prince of Pless through the Western Pennsyl-

vania coke region. The Baltimore and Ohio was then building a large new yard at Connellsville and, having walked over the work, the Prince asked why in so large and modern a construction I was erecting a wooden engine house. I explained that I had had to tear down many fine structures built of brick or stone by my predecessors and did not want to bequeath to my successors any qualms of conscience when they had to destroy my work.

The engine house should be equipped with adequate stalls, about one for every two or three locomotives using it, to take care of the running repair and dispatching work and it should have a machine bay with suitable, up-to-date fixed and portable tools. Other important auxiliaries are modern inspection pits, hoists and overhead traveling cranes running entirely around the house, drop pits, adequate day and night lighting, heating and ventilating, with smoke-jacks so placed as to insure the rapid disposal of smoke, perhaps best secured by having them lead to a single large stack; hot water wash-off and boiler wash-out equipment, power-operated turntable of adequate capacity and length; material and supply storage and disbursing plant; and various other "shop kinks" and handy appliances for expediting terminal handling and repairs in order to reduce to the minimum mechanical delays and lost use of locomotives.

The work on half the engines entering the roundhouse can be done within one hour each and covered repair pits outside the house may be used. The inspecting pits should have pneumatic tube connection with the roundhouse foreman's office for forwarding inspection reports so that assigning repair gangs to the work may be expedited. Against the possibility of a breakdown on the part of the ash pit crane, if one is used, a locomotive crane should always be available. In fact, the locomotive crane, ready for any emergency and capable of doing many things, must be regarded as almost indispensable in the operation of any real locomotive terminal.

Subsidiary shops for light repairs to a limited number of locomotives can be used to advantage as parts of engine

houses at the larger intermediate terminals, relieving the main erecting shop of minor work and furnishing a strong force that can be economically drawn upon by the engine house in supplementing its regular "hot-work" repair force. The delay to engines, where it is necessary to bring over from the erecting shop a force of repair men or to carry back and forth the parts for machinery, is very great and substantially reduces the ability to use the power as well as entailing costs that should be avoided.

71. Barracks.—Opinions differ widely as to the relative advantages of the railroad Y. M. C. A. (first organized in 1872 at Cleveland, Ohio, on the Cleveland & Pittsburgh Railroad) and company barracks for the accommodation of the lay-over crews. Conditions of size, character, and growth of the community, the general environment, nature of runs, and operating conditions, make this a problem to be resolved by analysis of local conditions. Generally, I have provided a barracks connected with the engine house so that the men might, as far as possible, obtain baths, meals, and sleep comfortably without having to go from under shelter. Proper sanitary arrangements are too often neglected. Entirely adequate lockers will encourage the men to provide proper dress for all weather conditions, which is a great advantage in variable climates. For successful administration great cleanliness and well-selected, well-cooked meals at reasonable prices are essential.

A further advantage of a barracks is the provision of a separate lunch room for the shop department heads, where once a day they may come into intimate personal contact and exchange information, suggestions, and ideas.

72. Back Shop.—The nomenclature used by the shop and equipment forces is very loose and conveys no sharp impression. The work done in keeping the locomotive in first-class condition for use divides into running and classified repairs, about an equal amount being spent for each class during its active life.

The classified repairs are taken care of in a group of activities, scattered in a variety of buildings or concentrated

into a few. In their totality they are spoken of as the back shop, dead work shop, or classified repair shop. This back shop consists of several units: the erecting shop; smith and hammer shop; iron, steel, and brass foundry; rod, driving and truck wheel, axle, pin, shoe, and wedge work; fire-box, boiler, superheater, tank, cab, and sheet iron work; and jacket and tin work; etc.

The back shop is a strong fortress of transportation. It is in connection with the condition and supply of power that the relations between the transportation and motive power officers become intimate. The success of the former is largely conditioned by the intelligence, capacity and fidelity of the latter, and personal contact between them must be almost continuous. So long as the back shop, on adequate schedule, keeps the power in such repair that it is usable to its full hauling capacity, half of the superintendent's troubles are behind him and many of his activities secure. This shop should be located as near as practicable to the motive power center of gravity of the district which it serves. In determining this location it is desirable that locomotives should be brought to and sent out from the back shop over *several different lines,* thus distributing the reduction in tonnage arising from disabled locomotives and from newly repaired locomotives while being broken in. The back shop may be expected to take care of general repairs to locomotives as they come in, and this work should not require the detention of the locomotive, on an average, over twenty working days, so that one may reckon on each erecting pit protecting fifteen locomotives per annum. This time may be shortened by carrying an ample supply of replacement parts, and also by carrying, already assembled, some of the more important general parts, such as boilers complete with fireboxes. I have in mind one case where I found 160 locomotives awaiting heavy repairs and requiring firebox renewals. An analysis developed that we could purchase a number of complete extra boilers and fireboxes for the various classes of locomotives awaiting shop. Extra boilers were purchased, with the result that the 160 locomotives were

placed into service in about one-half the time that would otherwise have been required with much less cost for repairs, and a much needed increase in available service.

There has been much controversy over the relative merits of the longitudinal and transverse placing of locomotives. As a rule the advocates of the longitudinal shop are officers who are graduates of the technical schools, while those who advocate the transverse shop have come up from the bench. Having to build a new shop, I had the subject thoroughly canvassed and found the reasons for and against each type to be generally as follows:

The transverse shop has the advantage of a ready movement and distribution of the dismantled and assembled parts between the erecting pits and the machine shop, and affords an excellent opportunity for supervision; one trip of the foreman the length of the shop will enable him to see every workman. Its disadvantages are outstanding. The operation of the transfer table is interfered with by heavy snows, and extensive trouble is experienced with the doors at each erecting pit. Machine groups and fitting tables cannot be placed to advantage. The boilers and tanks must be moved to a separate building for repairs, and all blacksmith work must be done in another. There is no floor space available for light repairs or storage of parts, and its use is without flexibility, the pit space being definitely assigned.

The longitudinal shop has the advantage of bringing the machine, blacksmith, boiler, and other shops under one roof and in close relation with the erecting shop, so that the workmen can go from one to another without exposure in bad weather. Its disadvantages arise from the inevitable crosswise movements in transferring materials to and from the erecting pits; from the difficulty of supervising the workmen, several trips the entire length of the shop being necessary to bring them all under view; and from the necessity of storing wheels and other accessories outside the shop and later rehandling them.

Where piecework prevails and each man or gang is responsible for conduct and output, either type of shop may

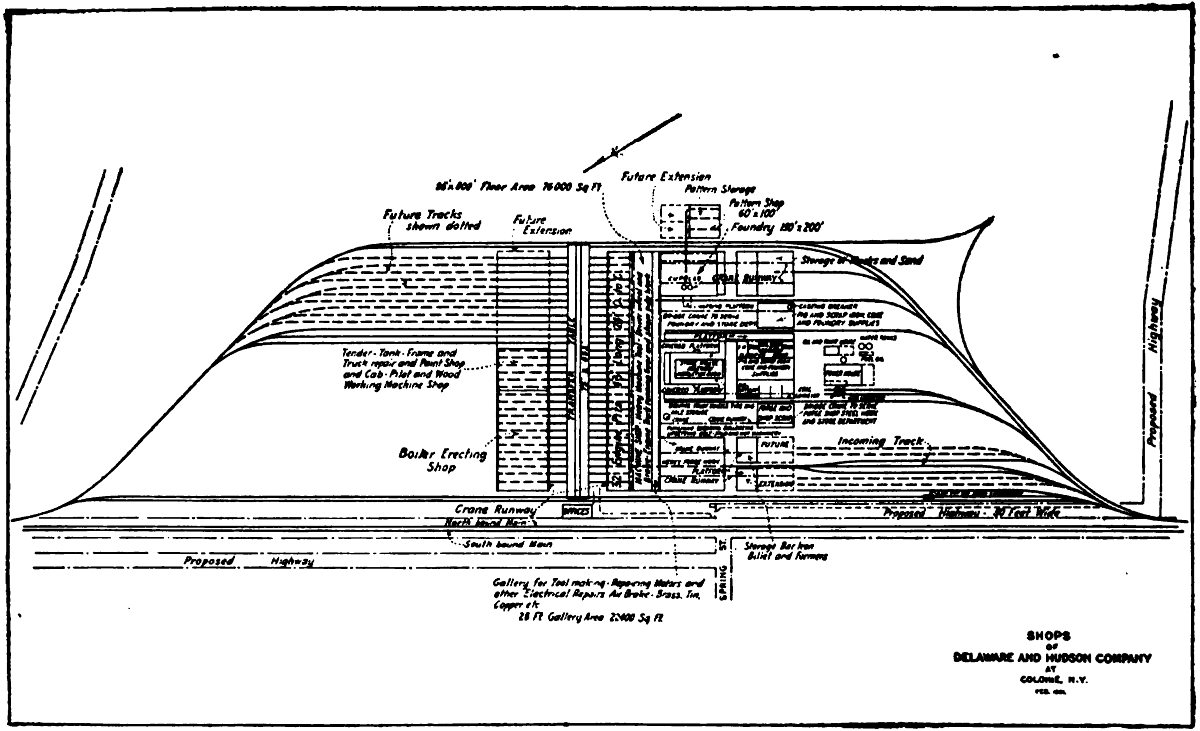

FIG. 15.—SHOPS OF DELAWARE AND HUDSON COMPANY.

be used, but where payment is by time and reliance must be placed upon the foreman for the industry of the workman, the transverse shop is definitely superior.

In the hope of working out an arrangement that would secure most of the advantages of both types, I put up a plant at Colonie, New York, adjoining the Watervliet Arsenal of the War Department (Figure 15). The erecting machine, blacksmith, boiler, and tank shops are brought under one roof and without intervening walls. All light tools are in galleries served by cranes. For the transfer table is substituted a central bay equipped with transfer crane; the transverse arrangement of the erecting pits is retained; transfer and admission to any pit track in the erecting shop is provided for, as well as the stripping, unwheeling, and storage of finished wheels and other accessories, and the wheeling and finishing of locomotives together with the fitting of driving boxes, eccentrics, etc. The ability to do this work on pits in the transfer bay increases the capacity of the erecting shop about 25 per cent.

At one end of the transfer bay, pits are located on every alternate track which are used for heavy boiler work. The modern boiler is so heavy that it demands crane handling. It may be taken off its frame by the crane and brought to these pits without putting it on trucks or even changing hitches.

Flues, as removed from the locomotive, are placed directly in suitable racks and the complete set picked up by the crane in one hitch and transferred to the flue rattler and flue machinery. The driving wheel department is in the transfer bay where all rods, boxes, etc., are removed and taken to the potash vats, which are located near the washout pit at the entrance of the shop. The wheels are stored in the transfer bay. All pipe material from each engine is held in racks placed between the tracks of the transfer bay, giving clear floor space between the engines on the erecting pits while still held in sets handy to the engine. Work is done on wrecked engines, broken frames are repaired, and, during periods of stress, heavy roundhouse work is taken

care of in the transfer bay without disarranging the erecting-shop floor or interfering with its work.

The advantages of supervision of the transverse shop are retained while the nearly square floor plan groups very advantageously the machine and fitting departments and reduces the movement of the different gangs back and forth between the stripping pits and the erecting pits about 35 per cent. In practice the locomotive to be shopped is brought over the washout pit just outside the building on the entering track from the west, having previously been washed by the locomotive washing outfit so that most of the heavy dirt and grease is removed before it enters. When it arrives on the washout pit the water is drained from the boiler and tank. The locomotive is then pushed on a stripping pit in the transfer bay, the side rods are disconnected, and pedestal binders and such of the pipe work as might interfere taken down. The locomotive is there lifted from its wheels by the 150-ton crane and carried down the bay to the point opposite the pit in the erecting bay where it is to be located, and drawn into the erecting bay by an electric winch; or the engine can be stripped and moved directly to the designated erecting pit by a 100-ton crane with which each erecting bay is provided. The locomotive is then set down on the shop trucks and the work of stripping is completed. Racks are provided at these pits for storage of piping and parts not needing repairs. In general, the reverse of this programme is followed with outgoing locomotives, a separate exit track along side of the incoming track being provided for this purpose.

The direct and short movement of parts to and from their respective repair zones, the flexibility in meeting irregular scheduling without interference with heavy classified work, and the advantage in northern climates of little outside trucking increase efficiency over the transverse or longitudinal shop by at least 10 per cent, and to this is to be added the 25 per cent greater capacity.

Most careful consideration should be given to the selection of machine tools, and the work should be carefully

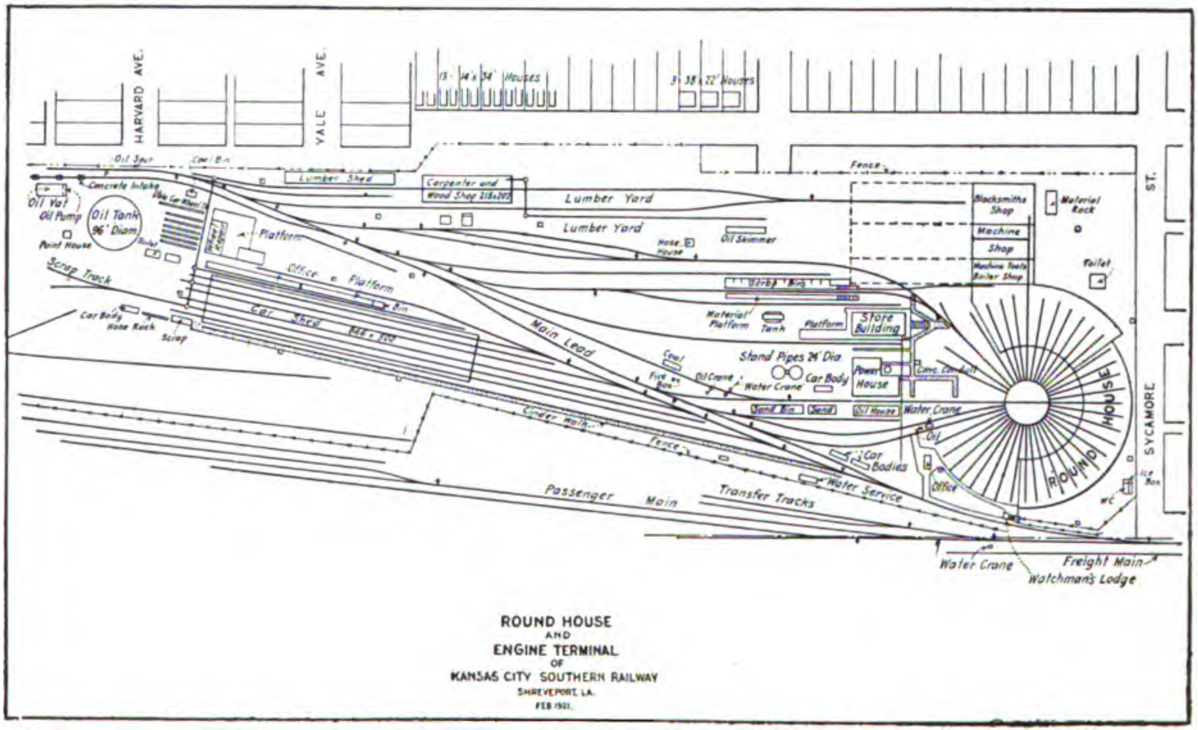

Fig. 16.—Round House and Engine Terminal of Kansas City Southen Railway.

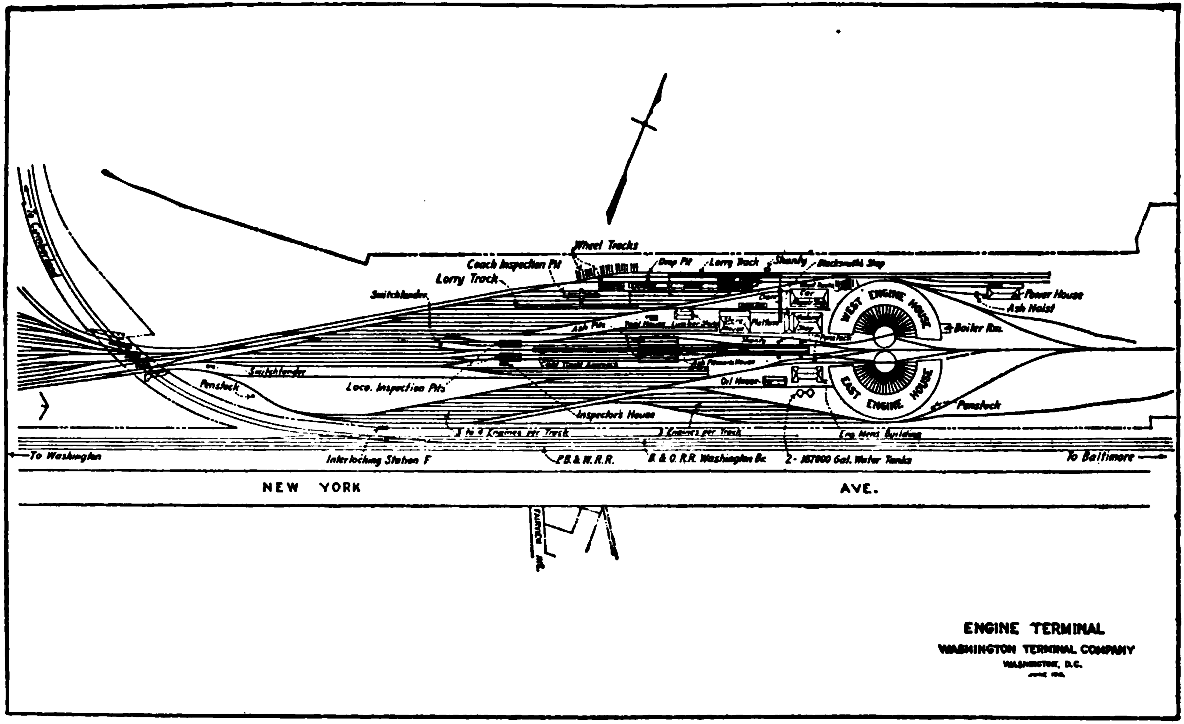

FIG. 17.—ENGINE TERMINAL OF WASHINGTON TERMINAL COMPANY.

checked over to determine whether or not it is in sufficient volume to keep busy a highly specialized and modernly designed tool. Care should be taken to see that the productivity of the machine is insured by a proper supply of jigs and fixtures. In designing new shops the same care should be taken to secure the advice of interested officers as in designing a new yard.

It should always be kept prominently in mind that work done in the roundhouse and erecting shop is but means to an end. The end sought is the useful work of the locomotive. We should, therefore, strive for increased mileage between shoppings and to this end give careful consideration to water conditions, to day-to-day attention to minor repairs, make sure that the more important work is first-class in all its details, especially the work in the boilers, fix definitely a control over the engines so that responsibility for their condition can always be placed, and, beyond all this, determine all operations by well-thought-out and adhered-to methods, and avoid as a plague constant changes for expediency.

73. Locomotives.—The steam locomotive stock at the present time on the roads that were under federal control is as follows:

PRESENT LOCOMOTIVE STOCK OF FORMER FEDERALLY-CONTROLLED ROADS

	Total Number	Tractive Power, Average, pounds	Weight on Drivers, Average, pounds
Double-acting cylinders....	61,336	30,500	135,000
Two-cylinder compound....	500	32,000	145,000
Four-cylinder compound....	1,300	33,000	148,000
Mallet articulated compound	1,750	79,000	350,000

These are divided approximately as follows:

Number of locomotives, total	64,886
Number equipped with coal stokers	4,010
Number equipped for fuel oil	3,358
Number coal fired by hand	57,518
Number equipped with superheaters	24,242
Number equipped with firebrick baffle walls	34,824
Tractive power, average, lbs	35,100

The things demanded in a steam locomotive are reasonable first cost, reasonable cost of repairs and replacements, maximum capacity for service within the limitations of weight, curvature, and clearances, ability to handle the heaviest gross tonnage at the minimum limitation of speed, positive control of mechanical operation, economy in fuel and water consumption, minimum labor for road and terminal handling, minimum number of parts, and an ability to perform continuous mileage.

Marked progress has been made in the development of the steam locomotive—largely, however, an increase in size, weight, evaporating capacity, and hauling power. The principal advances since the "Rocket" have been the introduction of higher boiler pressure, firebox baffle walls, compound engine, superheaters, and the articulated locomotive. Much remains to be done to improve the thermal machine efficiency and reduce smoke, cinders, sparks, and noise. There should be a closer approach to the degree of refined workmanship for construction and upkeep that obtains in the machinery which produces efficient and economical power for other modes of travel.

The heat that raises the temperature of the water in the boiler and finally explodes it into the vapor of steam acts in three ways:

1. The transformation of the molecular energy of a hot body into the wave motion of the surrounding ether and the propagation of these ether waves through space is termed *heat radiation.* In a locomotive boiler, when the combustion heat transferred through the firebox plates and boiler flues and tubes is applied to those heating surfaces directly, the radiant effect of the incandescent combustible and non-combustible particles that have passed through the minimum distance is from 20 to 25 per cent greater in efficiency than is the heat-transfer efficiency when convection only is available.

2. The process whereby the diffusion of heat is rendered more rapid by the movement of the hot substance from one place to another is termed *convection.* In the present locomotive boiler by far the greatest proportion of the heat is

imparted to the evaporating and superheater surfaces by convection. To it we largely owe the ability to generate a boiler horse power for an average of less than 2 square feet of evaporating surface.

3. The transmission of heat from one body of high temperature to another body of low temperature by contact, and from one part of a body to another part, is termed *external and internal conduction.*

There is much loss of power through the radiation of the heat to the atmosphere from all parts of the locomotive boiler and machinery that generate or contain it. To overcome this the boiler, firebox, cylinders and cylinder heads, steam chests, and other radiating surfaces should be properly lagged and certain machinery parts should be kept polished. There would seem no good reason why these radiating parts should be left exposed in the way they generally are with the resulting fuel and efficiency losses.

The greatest loss of heat is that carried off in the smokestack gases, sparks, and cinders. Adding to this the heat losses due to combustible material in ash, vapors of combustion, carbon monoxide, and otherwise, an average of from 25 to 40 per cent of the heat in the fuel as fired is unabsorbed by the boiler and superheater.

The steam thus generated from heated water varies in quality, owing to deterioration caused by water carried over into the cylinders with the steam. The boiler, with a very small steam space at its top, has the water level close to the throttle valve, and water from the back-lash or surge after swinging against the firebox tube sheet is picked up by the escaping steam. The delivery to the cylinder of dry saturated steam from the boiler is a function of the superheater, which, while generally considered a part of the boiler, has no relation to it in its individual function, which is to evaporate by heating the 4½ to 5 per cent of entrained moisture in the saturated steam delivered to it.

The use of superheated steam has done more to improve the performance of the steam locomotive than any change that has been made in recent years. Superheating is, as the

term indicates, adding heat to the steam. Since efficiency is equal to the difference between the initial and final temperatures of the steam, divided by its final temperature, it is apparent that any increase possible in the initial temperature of the steam is of great importance. Among its other advantages is the outstanding one that superheated steam is most efficient when the engine is working hardest, whereas saturated steam is at its worst under these conditions. The superheated steam increases the drawbar pull at 20 miles per hour about 15 per cent, reduces the amount of fuel used from 10 to 45 per cent, and saves about 35 per cent in the water evaporation per unit of power developed. Disappointment is sometimes expressed that with the installation of the superheater no saving of fuel is effected. It will usually be found in such cases that the saving in coal and water that the superheater made possible has been utilized in greater steam production and to obtain increased power or increased speed.

Extended rod-end carriers for the front ends of both valves and pistons have improved cylinder economy, and with the use of superheated steam, additional attention has been given to the waste of steam heat and power at these points, to avoid reduction in the thermal efficiency of the locomotive.

At the present time, for every 100 horse power in steam used, not more than approximately 60 per cent is actually utilized in producing tractive power. Of the waste through the exhaust about 75 per cent is more or less economically employed in producing the draught for combustion, evaporation, and superheat. The ability of the locomotive to furnish drawbar effort or tractive power is further reduced by the demand made upon it to supply saturated steam to various accessories of its own and for train operation. For example, a modern freight locomotive may be required to furnish power to operate stack-blowers, coal pushers, mechanical stoker conveyor and distributor, drifting valve, ash pan blowing and thawing device, feed-water heater pump, injector heaters, air pump, flange oilers, headlight electric

generator, grate shaker, superheater damper, hose sprinkler, fire pumps, and booster engine. Power also has to be furnished to supply a very large amount of compressed air for use in operating various accessories of the locomotive, such as the locomotive brakes, train brakes, power reverse gear, mechanically operated fire door, bell ringer, track sander, cylinder cock operating cylinder, and the tender water scoop.

Compressed air is one of the most expensive methods of transmitting power. Whenever possible the single-stage system now in use on a majority of the locomotives should be replaced by the cross compound steam and two-stage air compressors, with intercooler between the air cylinders. The cost of furnishing compressed air is from $200 to $600 per locomotive per annum, based on six hours service of the locomotive each day and on coal at $2 per ton on the tender. The substitution of steam for compressed air for many of these purposes would be economical and would reduce the drain on the boiler. There are cases where superheated instead of saturated steam might be used.

Steam is wasted through safety valves, and the energy lost by radiation and condensation. All these represent heat that does not go to the engine cylinders for the development of drawbar pull.

Steam is also wasted by improper cut-off for speed and load conditions, and the use of the throttle valve to control speed.

Other economical devices in recent practice are steam-heaters and flue-gas economizers for boiler feed water, and the outside valve gear accessibly located outside of the frames and driving wheels and driven from both the cross-head and an eccentric crank, of which the Walschaert was the pioneer. Tests made show that valves out of adjustment are responsible for from 8 to 21 per cent increase in fuel consumption per ton mile as compared with valves properly set. These outside valve gears all have the disadvantage of a constant lead and of being affected by the vertical displacement of the axle. It is interesting to recall that the

Stephenson valve gear, through its favorable lead for various points of cut-off, gives one of the best and most flexible steam distributions for locomotives that we have ever had.

The exhaust steam feed water heaters have the advantage of reducing the noises incident to the steam exhausting from the main and auxiliary engines. Experiments are being made with a fan driven by exhaust steam for the production of draught in the firebox. It is hoped to reduce the back pressure from 15 pounds to 7 pounds when the engine is working at full capacity; to catch and return to the firebox or ash pan, as may be desirable, 95 per cent of the cinders, while reducing the noise now made by the exhaust steam; and to provide the equivalent of an automatically adjusted exhaust nozzle.

Experiments are also being made in the development of an automatic exhaust nozzle control mechanism, the purpose being to overcome the present trouble with lack of vacuum in the firebox and poor steaming qualities of locomotives equipped with the feed-water heater, also increasing the value of the stoker-equipped locomotive by equalizing the combustion rate and preventing the large cinder loss.

The only useful form of friction that may be mentioned in connection with the steam locomotive is that which occurs between the driving-wheels and the rails and through adhesion makes possible its motion. The coefficient of friction of a rail washed thoroughly clean and dried is about 26 per cent. Moisture, leaves, grease, etc., materially reduce this coefficient. If sand is evenly distributed along the top of the rail the full coefficient of friction may be restored. Sanding devices in use fall short of giving this result by about 25 per cent.

All other friction, whether from oscillation, concussion, rolling, wheel flanges and treads, journals, cylinders, valves, valve gear, crossheads, center and side bearings, coupler side play, and the like, absorbs a very considerable percentage of the power developed by the steam and diverts it from its useful work. The loss of power in an engine developing

2000 indicated horsepower at a speed of 30 miles per hour is about 325 horsepower, or 16.25 per cent.

The locomotive is subjected also to resistance due to grades, curves, weather, wind, and the inertia of the air through which it forces its way. When one considers that, assuming the atmospheric resistance on flat, abutting surfaces to be 100 per cent, this air resistance on a double cone, with apices ahead and back, is only 25 per cent, it seems regrettable that the shape of a steam locomotive with its accessories makes the use of relatively smooth outside surfaces generally impracticable.

It is false economy to restrict too much the use of lubricants or to employ inferior lubricants that result in excessive friction; any apparent saving thus effected is expended many times over in delays, repairs, and fuel. The cost of lubrication is but about 0.2 per cent of the total expenses, whereas fuel and locomotive repairs absorb approximately 10 per cent each. Nevertheless it is important to realize that oil and grease are so generally applied or used in an improper manner that probably no locomotive supplies are handled as ignorantly and wastefully.

There have been instances both of the breakage of rails and of their being given a permanent set through the handling over the track at too great speed of new locomotives with side rods removed. While it is not possible perfectly to counterbalance a two-cylinder locomotive, the lack of counterbalance is for all practical purposes compensated in good designing. With the introduction of high-grade alloy steel this condition will be still further improved. More damage is likely to be done to rails by running engines with worn or slid flat spots on the driving-wheel tires.

The "plain locomotive" with its tender consists of some sixty-five assembled parts essential in all construction. The price of the "plain locomotive" may be taken as uniform for the per pound weight. What used to be called the "specialties" consist of some sixty additional assembled parts, of which many varieties, differing in design and merit, are in the market.

An interpretation has been given the word "specialties" by demagogues to foster the idea that they represent individual preferences of railroad officers; fads and fancies of extravagance and waste. They correspond, however, with what in the automobile are known as "accessories." The substitution of that term for "specialties" bids fair to remove one source of embarrassment. They are special appliances for firing, combustion, superheating, steam distribution, and utilization, feed-water delivery, lubrication, insula-

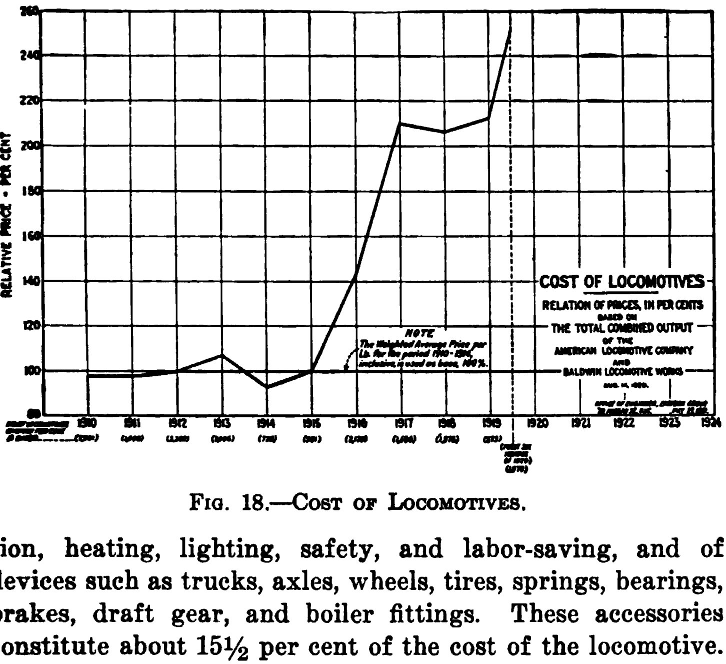

FIG. 18.—COST OF LOCOMOTIVES.

tion, heating, lighting, safety, and labor-saving, and of devices such as trucks, axles, wheels, tires, springs, bearings, brakes, draft gear, and boiler fittings. These accessories constitute about 15½ per cent of the cost of the locomotive. It is interesting to note that the number of accessories on the U. S. R. R. A. locomotives is double the number on the other engines in stock. To these accessories must be added the cost of the safety appliances required by the Interstate Commerce Commission, testing and inspecting of material, inspection during construction, messenger expense, freight charges from the locomotive builders' works, and necessary tools. But this contemplates only the new locomotive ready for its

FIG. 19.—ANALYSIS OF ORIGINAL COST AND TOTAL NUMBER OF PIECES TOGETHER WITH COST OF LIGHT AND HEAVY REPAIRS, FOR A 2-8-0 LOCOMOTIVE

Main Division	Original Cost, Per Cent [1]	Parts [2]	Number of Pieces [2]: Principal Pieces	Number of Pieces [2]: Bolts, Nuts, Rivets, Studs, Pins.	Number of Pieces [2]: Total	Cost of Light Repairs, Per Cent [3]	Cost of Heavy Repairs, Per Cent [3]
Boiler	21.0	(1) Boiler and included parts	1702	....	....	5.30	23.10
		(2) Grates and ash pan	99	....	....	2.50	3.70
		(3) Brick arch	0	....	....	....	....
		(4) Lagging and jacket	50	....	....	3.60	3.70
		(5) Boiler fittings	78	....	....	4.80	3.50
		Total	1929	5428	7357	16.20	34.00
Underframe	11.5	(1) Bumper and draft gear	19	....	....	.10	.20
		(2) Frames	2	....	....	17.00	2.70
		(3) Frame details	60	....	....	4.90	7.20
		(4) Pilot	1	....	....	.10	2.00
		(5) Springs and rigging	116	....	....	.80	2.70
		(6) Foot plate	6	....	....	....	....
		Total	204	1485	1689	22.90	14.80
Running Gear	41.5	(1) Axles, wheels, etc	78	....	....	32.50	17.30
		(2) Brake equipment	97	....	....	1.50	2.70
		(3) Cylinders and valve gear	184	....	....	18.40	15.70
		(4) Engine truck	19	....	....	(Included	in No. 1)
		(5) Trailer—if any	....	....	....	"	"
		Total	378	715	1093	52.40	35.70
Other Parts	11.0	(1) Cab and attachments	26	....	....	.60	1.60
		(2) Bell, sand box, etc	70	....	....	.30	1.60
		(3) Running boards	63	....	....	.20	.90
		(4) All piping	320	....	....	6.70	2.30
		Total	479	700	1179	7.80	6.40
Tender	15.0	(1) Cistern	62	....	....	.40	4.70
		(2) Underframe	94	....	....	.20	1.20
		(3) Trucks	132	....	....	.10	3.20
		Total	288	3350	3638	.70	9.10
Total	100.0		3278	11,678	14,956	100.00	100.00

[1] Information was obtained from The American Locomotive Co., and Baldwin Locomotive Works based on a 2-8-0 locomotive.
[2] The information is based on data obtained from the D. & H. Company covering a 2-8-0 locomotive, Type E-5.
[3] Information is based on repairs made to engines in the D. & H. Company's shops at Colonie, N. Y.

work. There must follow the breaking-in with its cost and inconvenience, including losses due to hauling reduced tonnage. The price curves on Figure 18 indicate the range of recent years and afford an explanation of the decision of those whose purpose it is to write down railroad values to contend for June 30, 1914, as a convenient date for that purpose.

The use of staggered rail joints in track laying results in considerable vibration and surging of tenders when first-class surface and alignment are not maintained. This necessitates, if the danger of derailment is to be avoided, the use of a flexible type of tender truck that will make it possible for each wheel always to follow and remain on the rail with which it is in contact without regard to any other wheel in the truck. Figure 19 gives analysis of original cost, number of pieces, and cost of repairs of a typical freight locomotive.

74. Stokers.—There are now between four and five thousand locomotives equipped with mechanical stokers, nearly one half of them having been built during federal control. Those who oppose them assert that stoker-fired locomotives burn from 10 to 40 per cent more coal than hand-fired locomotives, including therein the additional coal burned to produce the steam for operating the stoker equipment; that the cost for stoker apparatus is large; that repairs range from two cents to four cents per locomotive mile; and that they are in bad order so much of the time as to be a real hindrance.

Those who favor them assert that the repair cost of maintaining a stoker ranges between $30 and $50 per month, and from one to two cents per engine mile, and that with a competent crew it should cause no inconvenience. They claim that any increase in the amount of coal burned is reflected in more work done, and that it will always be economy to exchange a dime's worth of coal for a dollar of earnings. They picture the stoker as applied for the sole purpose of amplifying the output of the locomotive, the sacrifice, if any, being justified by ability to obtain maximum capacity.

Freely admitting that locomotives which can be fired by hand to maximum capacity through sustained periods do not require stokers, they contend that, where the tractive power approximates 50,000 pounds, the grate area 60 or more square feet, and the coal required for sustained periods 4000 pounds per hour, only stoker-firing will enable a full head of steam to be kept up and the full power of the locomotive to be exerted; that by this means may be obtained decreased traffic density, savings in crews' wages, and reduction in the number of locomotives used.

The claim is further made that the firing by hand of the large engines for any considerable length of time probably approaches the limit of endurance of the men, especially during the warm season, and that the stoker will afford relief and will be accepted as a substitute for the second fireman so frequently requested. I have not regarded with enthusiasm the introduction of the stoker in view of our successful experience with many engines burning anthracite with from 50,000 to 67,500 pounds tractive power and 100 square feet grate area.

Due recognition is not given to the large amount of drifting done in most runs and the small amount of time—10 to 16 per cent—in which the fireman is actually engaged in shoveling coal into the firebox. When one considers the number of men on the locomotive available for hand-firing, a fireman, and always one, and often two, brakemen, the interference of labor organizations with management by undertaking to prescribe and separate the duties of these men, where it operates to defeat an economical practice or compel the installation of costly appliances, is a gross outrage on the public which has to support the properties.

The difference in efficiency between a skilled and an unskilled fireman is as much as 22 per cent. The substitution of an assistant fireman for the brakeman would afford not only protection against undue fatigue but opportunity for apprenticeship and valuable instruction, insuring at all times an ample supply of trained firemen.

One of the greatest and simplest improvements can be

effected by increase in boiler pressure, in combination with greater quantity and better quality of saturated steam production, higher and more uniform superheat, and the use of compound engines.

Further, owing to the small amount of fuel required to raise the temperature of steam, once the water has been vaporized, as compared with the fuel necessary to effectuate the vaporization, the high pressures are obtained at relatively much less cost. A locomotive equipped for generating 350 pounds steam pressure and 300 degrees superheat, representing a total temperature of about 736.4 degrees Fahrenheit, will, as compared with one using 200 pounds steam pressure and 300 degrees superheat, representing a total temperature of about 687.9 degrees Fahrenheit, require an increase of only 18 British Thermal Units, or 1.3 per cent in total heat in the steam, and an increase of only 48.5 degrees, or 7.05 per cent in the temperature of the steam, to produce an increase of 150 pounds, or 75 per cent, in the steam pressure.

The cost per mile of service, including the wage scale instituted by Decision No. 2 of the United States Railroad Labor Board, will run about $1.484 per mile of engine service, distributed as follows:

Fuel	$0.603
Repairs	0.413
Engine crew	0.280
Enginehouse expenses	0.161
Other supplies	0.027
Total	$1.484

This represents a total expenditure of about $41,350 annually per locomotive.

75. Future Possibilities.—What then remains to be done to improve this machine, so vital to the conducting of transportation, and to insure its perpetuation in competition with other motive power, or means of transport by increasing train loads, reducing transportation and mechanical delays, and saving fuel and labor?

Serious consideration is being given to the possibilities of improvement in the following details:

1. Steam at a pressure of about 350 pounds to be employed, superheated about 300° Fahrenheit.
2. Improved boiler, furnace, and front-end design, and appliances.
3. Greater percentage of the total weight available in adhesion and a lower factor of adhesion.
4. More efficient methods of combustion.
5. Use of exhaust-steam heater and flue-gas economizer for boiler feed water.
6. Better steam distribution and utilization.
7. Reduced cylinder clearances and back pressure.
8. Lighter and better-balanced reciprocating and revolving parts.
9. Lower heat, frictional and wind resistance losses.
10. Improved safety and time, fuel, and labor-saving devices.
11. Boosters, developing 25 per cent additional drawbar pull and working on trailer wheels or tender truck.

76. Service Power.—The locomotives used in the movement of freight are road, pusher, and yard. The second are usually taken from the stock of the first, and the yard engine is frequently a converted road engine.

Progress in locomotive development during the past few years has been largely in the direction of devices that can be applied to existing power, so that it is often possible to transform an existing locomotive into a machine as efficient as one of equal power just out of the builder's shop. Further, by the substitution of a new frame, eliminating the pony truck and respacing the wheels to balance the engine, the lighter road power can be economically converted into switching power. In this way much further use could be had out of power currently becoming obsolete.

It is to be regretted that no comprehensive data are available for the locomotive stock of the country as to the type, wheel arrangement, boiler pressure, size of cylinders, weights, tractive effort, etc. If each company would print in its annual report a statement as shown on Figure 14, many useful deductions might be made.

77. Compound Locomotives.—Twenty years ago almost every new locomotive had compound engines using steam a

second time at reduced pressure but in larger cylinders. Owing to mechanical difficulties and failure to appreciate the increased work done, the type was abandoned. It has, however, worked out well in stationary engines and steamship practice, and should be brought to success in locomotive practice.

The first designer of compound engines for locomotive use was A. Mallet, a Frenchman, in 1877. They were introduced into this country in 1889 by the Baltimore & Ohio Railroad, but not until after there had been more than one thousand of them built and after they had been in use for twelve years in Europe.

The failure of various types of cross, four-cylinder balanced, and tandem compound locomotives to produce the predicted economy was due largely to indifferent design, low boiler pressure, excessive condensation, lack of proper maintenance and operation, poor fuel, and road failures. The clearance limitations then existing restricted the size and arrangement of the low-pressure cylinders, while at the same time the double-acting cylinder superheated steam locomotive, giving greater hauling capacity and economy, diverted attention from this type.

These compound locomotives embodied many advantageous features, such as greater starting and hauling capacity per unit of weight, less evaporating surface per indicated horse power, reduced fuel and water consumption, and boiler repairs; and there seems no doubt that with the now successful use over a period of years of the Mallet articulated compound locomotives, their return to favor for freight service, in combination with higher boiler pressures and superheated steam, may be expected.

The demand for the utilization of all the expansive power in the steam before its final exhaustion into the atmosphere will continue to invite effort.

78. Articulated Locomotives.—I had been much impressed with the possibilities of the articulated locomotive designed by Fairlie for the 2-feet gauge Festiniog Railway and had long in vain urged my superiors to utilize its

features. I had taken advantage of a trip to the City of Mexico to ride on articulated engines in service on the Mexican Railway, and when I became president of the Baltimore & Ohio I persuaded Samuel R. Callaway, then president of the American Locomotive Company, to go to Mexico City with me to see these engines in operation. Mr. Callaway was very cordial about it and sent an engineer to Europe to inspect the engines in service there, including the modifications made by Mallet. Practically all these locomotives were on 60-centimeter or 2-feet gauge lines, and the adaptation to American conditions, which was largely the work of our general superintendent of motive power, John E. Muhlfeld, was the virtual design of a new type. With it we brought over the Walschaert valve gear, now (with its modifications) applied to all new construction but then strangely neglected, and built the first Mallet in time for exhibition at the World's Fair in St. Louis in 1904. Since then this engine has been utilized for the special service to which it is peculiarly adapted and there are now in service in the country more than 1750.

79. **Wreck Train.**—The wrecking outfit is a tool that the transportation officer will have to use only too often. In 1893 A. S. Vogt, mechanical engineer of the Pennsylvania Railroad, S. R. Harned, mechanical engineer of the Michigan Industrial Works, and I were members of the transportation jury at the Columbian Exposition, and as a group examined all the exhibits of wrecking outfits and tools, including line drawings and photographs of foreign exhibitions. At that time the crane car, with jack arms to prevent overturning, carried a short pillar and had very little lifting capacity. We had many discussions over the details suggested by the exhibits, with the result that we ordered a wrecking crane of the Michigan Industrial Works, embodying those features we thought applicable, that was the first of the modern high capacity wrecking cranes. The wreck train outfit should be complete and up-to-date in every detail with adequate sleeping and mess accommodations for the crews. I used to feel that conditions on an operating division could be fairly well

judged by the time it took to get out its wreck train. We handled the wreck train much like a fire engine. The wreck crew was built up of car repairmen and some mechanics and laborers from the erecting shop. Buzzers were installed in their bedrooms and actuated at night over a wire circuit by the train dispatcher. We got out the trains in fifteen minutes in the day time and thirty minutes at night, and any failure to do so was painstakingly investigated. Not only is good service in this respect a great comfort to the operating officer, but it may acquaint him with many things if he will occasionally take a hand himself. I remember once picking up a box car that had gone down the bank only to find its lading consisted of one empty demijohn. The car was an R. Q. C. (Regardless Quantity Car) from Cleveland to Mingo Junction, and an examination of the records of loading led to a request for and withdrawal of the service. Our rule in reporting a wreck was first to give an estimate of time required for clearing track, and where this was two hours or more we dispatched no freight trains from the terminal yards until the track was restored.

80. Snow Plows.—The handling of snow is a work of importance, the regularity of traffic in the winter depending much upon the alertness, the industry, and the ingenuity of the men in charge of snow removal and of the tools furnished them.

As soon as the depth of snow begins to look threatening, or as soon as it begins to drift, work should be started and continuously prosecuted. The flangers and pilot plows can often be made to suffice, and these can be relied upon when the snow is not more than three feet in depth. For three to six feet, and this is the extreme range likely to be dealt with east of the upper Mississippi Valley and the Rocky Mountains, various forms of the push-plow are in use. The plow should lift the snow and throw it aside without crowding. To that end it is built with square nose, riding but little above the rail, the upper part V-shaped and carrying wings for cut widening. For double-track service they are built right and left hand or the plow is run up one track,

turned and run back on the other. The machine plows, which came into use in 1884, are now built in the rotary type only. Their use is essential where snow becomes hard, packed or frozen, or exceeds eight feet in depth. They are machines of great power, throwing at running speeds of 6 miles per hour a solid stream of snow 4 feet in diameter, from 50 to 150 feet from the track. The story is told that in a cut on the Colorado Midland, when a herd of cattle had been frozen to death under fifteen feet of snow, the "Rotary" "went right through the cut, shedding beefsteaks all over the country."

81. Track Inspection Car.—One of the Pennsylvania officers, coming back from Europe in the 1870's, brought with him the germ of an idea for the mechanical testing of track. He set up an "A" frame in the center of a car over the rear truck and hung in it, so that it would swing like a pendulum, a spike maul; on either side and at a calculated distance from the maul he set up a brass gong. When the car passed over a joint sufficiently "down" to give through the force of gravity the required motion to the spike maul it would swing out and strike the gong. I well recall the first time the car was run over the New York Division and the satisfaction with which Supervisor Jim Smith announced that the gong sounded only once on his district. From this beginning the engineers developed a fairly satisfactory car for testing track conditions but it was put to little practical use and finally dismantled.

The track of the Pittsburgh Division, always hard to maintain, had got into unsatisfactory condition. The President was coming out on his annual inspection and something had to be done. I borrowed the old "A" frame device and installed an air brake reservoir filled with whitewash, which could be squirted against the rail by means of an electrically controlled valve. We ran this car down one track and back over the other every day for a week, spotting the track every time the gong rang. The device was crude. We could not hit the low spot by a rail length or so, and left a mark a rail length long. But the indication was sufficient for the

purpose, all the available force was concentrated on line and surface and we brought the condition of the track up in short order.

We then went to work seriously on the design of an inspection car, utilizing what had already been done. Placing a lever board over a six-wheel truck, we got electric contact and circuit breakers over the two outside wheels and could automatically mark a couple of feet of the inside web of the rail within 3 feet of the low spot, the apparatus being set for ¼ inch depression. When I went to the Baltimore & Ohio I interested Sellers & Company, makers of instruments of precision, and further perfected the device and used it to great advantage, organizing on some of the divisions special line and surface gangs and not allowing the track to be surfaced except as marked. All the indications were recorded on a single piece of tape, and, by cutting this into five-mile sections and pasting them vertically over each other, recurring defects were made apparent and radical measures could be taken for their elimination. With the modern heavy rail no permanent set is given after the passage of a train and some of the old guides that used to direct the section foreman are no longer available.

While on the Baltimore & Ohio Railroad, I remember once in Philadelphia hearing first from McCrea and later from Cassatt that the surface on the Newark Division was very bad. They paid 80 per cent of the maintenance cost for rental and they felt that it should be put in more satisfactory shape. I told them there was nothing the matter with the track except that it was dirty, the sod line had not been trimmed nor the weeds scuffed, but the surface was all right. I offered to run the track inspection car from Pittsburgh to Newark with their engineers aboard and to bet a red apple that our track from Columbus to Newark was better than their track from Newark to Pittsburgh. If it was not, I would put it in any shape they liked. They took me up and lost the bet. Both were unusually good judges of track, far better than I, with more extensive experience. Here particularly, unless ceaselessly on guard we are sure

to be influenced by extraneous things and never more so than in the estimate of track conditions.

82. Dynamometer Car.—Much greater use should be made of the dynamometer car than is the practice of most roads. In competent hands it is a sure interpreter of many conditions and a great aid in bringing harmonious results.

Whenever a mechanical test can be substituted for the exercise of human judgment it is advisable to use it, subject, of course, to its economic justification. It is surprising how many of our tools and appliances would have to be abandoned were they not made "fool-proof."

83. Special Cars.—The transportation people use a considerable number of special cars. More than we, they use abroad special cars for handling locomotive fuel and cinders from the ash pit. For the transport of coal, the general gondola equipment is ordinarily used indiscriminately. There are also: (1) the supply cars used in the service of the general storekeeper, (2) the car used by the instructor on the book of rules, (3) the car fitted up for instruction on the air brakes, (4) the car for testing the accuracy of track scales.

84. Speedometers.—What I have said in speaking of the line and surface of track regarding the advantage of substituting mechanical tests for individual judgment applies in practically all phases of railroad operation. Very few enginemen are able to estimate with any reasonable accuracy the speed at which the train is moving and from that and other causes many of them fail to handle the locomotive so as to obtain economical use of steam. For a long time I have been using a reliable speed recorder, and recently there has been developed a device receiving its motions from the valve gear reverse shaft for determining and showing on an indicator disk the proper cut-off at which the engineman should operate the locomotive at varying speeds for the purpose of securing the most economical use and distribution of steam, in combination with a development of the maximum drawbar pull. With this same device is combined a speed, time, distance, and location recorder with a cut-off indicator and recorder, locked up in a box for inspection at the end of the run.

With the device: (1) the engineman has at all times before him on a dial in full view information as to just how he should regulate the motion gear to produce the most effective and economical results; and (2) the supervising officer is furnished a continual check on the performance of the locomotive and the work of the locomotive engineman as regards speed, time, distance, location, and fuel consumption during each run or each twenty-four hour period.

85. Narrow-gauge Railroad.—It may be of interest to indicate here the debt we owe the men who developed that now infrequent, but still, under suitable conditions, highly economical method, of transportation, the narrow-gauge railroad. There was a time when the management of lines of narrow gauge were stout advocates of the advantages of the system, active in its development, and maintained many of its practices well in advance of those of the standard gauge lines. The tractive power of the engine was relatively much greater, and the development of the articulated locomotive and many mechanical improvements were the work of narrow-gauge engineers. The increased capacity of freight cars and economy in the ratio of load to tare weights were the results of its practice, while the restrictions of space compelled the exercise of much ingenuity in the development of methods for the comfort and convenience of passengers.

The fact was that, for a score of years prior to the introduction of the narrow gauge as a commercial institution, standard gauge practice had stood still. The new field attracted many men of imaginative minds, well-trained and capable, and their activities for a time strongly threatened the older system. Unfortunately for them, everything they originated could be easily copied, and, in copying, could be improved to the extent that the restrictions of the space in which they were confined were removed.

The standard gauge, so-called, 4 feet 8½ inches, is after all a mere accident, the application to steam transportation of the wheel arrangement of the highway vehicles of England of the early 19th century. The struggles against it, on the one hand by Brunell with the 7-foot gauge of the Great

Western, and on the other by the promoters of gauges of 3 feet and 60 centimeters (about two feet), make one of the most fascinating chapters of railroad history. Were we now able, in the light of our experience and with due consideration to the volume and character of the traffic to be moved and its probable growth, to change overnight, as by a miracle, our entire transportation system and its related activities, beyond question we should on the one hand broaden out the standard gauge on our lines of heavy traffic, and on the other hand apply the narrow gauge in the building of "light railways."

Since wages have been brought to a uniform basis, and since the cost of fuel and other supplies is a function of the work performed, the economic differences in the two systems are largely confined to the original cost and the maintenance of the permanent way and equipment. Discussions in the literature of the subject relate to conditions now long passed away. In 1902 the National Railways of Mexico, which had been operated as a narrow gauge (3 feet) for 20 years, widened its gauge. The conclusion of its officers, as stated to me by E. N. Brown, then its president, as a result of their most careful study, was that the expense of maintaining the standard gauge was 33 per cent in excess of that for narrow gauge. In an examination of the matter in 1917, I reached the conclusion that, under the prevailing conditions and practices of the present time, the cost of maintenance of way of the standard gauge is 25 per cent in excess, and the cost of maintenance of equipment is 20 per cent in excess, of the narrow gauge (3 feet).

86. Comparison of Steam and Electrical Working.—In dealing with material things we have to do with three fundamental agencies—energy, matter, and electricity. Investigation in these fields is exceedingly active and we are likely at any time to obtain great gains in knowledge; but the present views of their nature are as follows:

Energy.—Energy is the capacity for doing work. Thermal energy, or heat, subsists in irregular motions of the smallest particles of matter, which cannot be traced on account of

the bluntness of our sensual perceptions, while all other forms of energy are in their essence mechanical and are more readily recognized in doing mechanical work. We can convert the whole of the energy possessed by any mechanical system into heat. We cannot perform the inverse operation and utilize the whole of the heat in doing mechanical work, though the availability of heat increases with the temperature. Heat is molecular motion; the total absence of molecular motion is the "absolute zero," approximately 459° below zero Fahrenheit, and has been reached within 2 or 3 degrees in laboratory experiments.

Matter.—All bodies contain small particles called atoms. These are complex storehouses of a size so minute that 200 of them must be placed side by side to be seen by the most powerful microscope known. Their shape is thought to be spherical. There are about one hundred different species, differing in size and still more in weight, each having almost the complexity of a personality. Atoms tend to form groups known as molecules. The formation or decomposition of molecules is effected by "chemical reactions." Both atoms and molecules have forces of attraction which tend to form the larger aggregates called "objects," or "bodies." The substances that do not decompose on heating are capable of existing in the three states—solid, liquid and gaseous.

Electricity.—There are two "kinds" of electricity, "positive" and "negative." It is thought that the "positive" electricity never leaves the atom, whereas "negative" electricity exists only in the form of electrons which allow themselves to be taken away from, or added to, the atom with relative ease. All electrons are thought to be exactly alike, spherical in shape and symmetrical in every way, and to be so minute that their diameter is but one one-hundred-thousandth of that of an atom, while they are so light that the weight of two thousand is no more than that of one atom of hydrogen. It seems not improbable that most of the phenomena of nature are due, in the last analysis, to electric attractions and repulsions, unlike charges attracting each other and like charges repelling each other.

It is important to keep in mind in thinking of electricity that it is not in itself power but is a convenient means of power transmission, just as compressed air or a combination of shafting, pulleys, and belts is a convenient means of power transmission.

The motive power officers are among the most progressive of all railroad officers, yet I have often doubted whether they now have the faith in the steam locomotive that that wonderfully efficient and adaptable machine so fully warrants. In comparing the relative values of steam and electric railroad working, there has been a vast amount of loose statement hardly justified by the facts and the extreme claims so attractively and confidently set forth by the electrical engineers seem to have staggered them. Some time since, in examining the operations of a 2 per cent grade division on a mountain line, I assembled the following as the important items for consideration:

87. *Effect of Winter Weather.*—While it is true that the radiation from a steam locomotive is greater in winter than in summer, reducing its effectiveness, and that the effectiveness of an electric motor is greater in winter than in summer because of the lessened tendency to overheat, it is also true that no difficulty has been found in securing the full steaming capacity and consequent tractive power of a Mallet engine in bad weather provided the engine is kept in proper repair and properly handled. The effect of cold weather, in a particularly bad winter, as shown by the train sheets of a mountain division much troubled with snow, has been to produce an average reduction in the engine rating in the district in question of about 5 per cent for the year. A very large portion of this has been due to the increased internal resistance of the cars, and this would affect the efficiency of the steam and the electric locomotive alike.

88. *Ease of Starting of Trains.*—It has been claimed that an electric locomotive can start a heavier train than a steam locomotive of the same tractive power because of the assumed steadier pull under electric traction. This has never been demonstrated. When it is considered that the loco-

motive does not start the train but merely starts the car next to it, which in turn starts the second car and so on, each after a perceptible pause in which the slack in the coupler draft rigging is being taken up, the improbability of this difference in starting power seems evident. This argument has been pushed so far as to maintain that reductions of grade below 0.4 per cent are valueless, on the theory that an engine will not start on the level a heavier train than it can haul on that grade. At one time this suggestion was brought forward with much earnestness. Controversial refutation of this position is happily unnecessary. One has only to look at the operations of the Virginian Railway, constructed and satisfactorily worked on a basis of 0.2 per cent grades.

89. *Braking on Heavy Grades.*—Through all the reports emphasis is laid on the ability of the electric locomotive to brake the train on heavy grades down to a speed of about 10 miles per hour without the use of the car brakes, the presumption being that it is impossible to brake the train safely in the ordinary manner. The Baltimore and Ohio has for many years operated successfully on 2 per cent grades in the vicinity of Cumberland, one of these grades being 17 miles in length. At the worst, all that is necessary for successful operation on such grades is a siding at intervals, on which the train can be stopped for about 10 minutes, allowing all heated wheels to cool before proceeding. Trouble from heated journals is not likely to be experienced unless the grade is longer than ten miles.

90. *Effectiveness of Electric Engine as Compared with Steam Engine.*—It is stated that because of the uneven tractive power of the steam compound locomotive, exerted intermittently by four cylinders, it can exert but 93 per cent of the tractive power of an electric locomotive having the same weight on the drivers. This is undoubtedly true. Its effect is either to require a steam locomotive with 7½ per cent more weight on the drivers or to increase the steam train mileage about 7½ per cent over that necessary under electrification. A second disadvantage of the steam locomotive is the increased weight necessitated by the tender and by

the general design of the steam locomotive as compared with an electric locomotive having the same driver load.

The train limitation laid down is 80 loaded or 100 empty cars. In the event of withdrawal of the number-of-car limitation of train load, it is theoretically possible, by combining electrical engine units, to obtain more tractive power under the handling of one engineman and one fireman than is possible with the steam locomotive. Practically speaking, the effect of this is greatly to increase the peak load, thus increasing the cost of the power house and of the electrical transmission lines. Study of the various reports indicates that here the economy limit is about reached with the 80 and 100 car train limitations now in effect.

As against these claims for the electric locomotive the fact should not be lost sight of that steam locomotive operation has an advantage of flexibility. It is possible to transfer surplus power from one part of the line where it is not needed to another part of the line where it can be used. This of course, is impossible under electric operation unless it extends over the entire property and unless the power houses have an unjustifiable peak load capacity.

91. *Fuel Consumption.*—Great economy of fuel consumption is claimed for the electric as compared with the steam operation. This is because of two assumptions:

First, the use of a cheaper class of fuel in the power house than can be used on a steam locomotive. In the territory in question there is so great a demand for fuel of all classes that the difference in the price of the fine and the coarse coal has practically disappeared.

Second, the type of boiler used in stationary plants is more economical in the production of steam than the locomotive boiler. This is true, but against it must be placed the loss of power in transmission over very considerable distances. It seems probable that in the territory in question the net saving in fuel consumption by the electric system is almost negligible.

Emphasis is laid upon doing away with delays account of taking water, coal, etc. The delay in taking coal will

occur only once on a trip, and with proper appliances need not be serious. The delays in taking water may be obviated by the use of Ramsbottom track tanks.

Emphasis is also laid on ability to use energy generated in holding back the train on the down-grade to assist in the movement of trains on the up-grade. It would appear, however, that, owing to thin traffic and because the force generated by an engine on the down-grade can be used only by an engine that happens to be on the up-grade at the same time, this conservation of force will not amount to more than 8 per cent. Much of the power so generated is lost in conversion from mechanical into electrical energy. When the surplus power cannot be directly utilized, it must be absorbed by artificial resistance at the power station. What the expense of this absorption is and whether the algebraic sum results in a gain or loss through the application of the braking power is not made clear by the reports.

By looking with optimism upon all phases of electrical working and predicating the most efficient installation, and looking with pessimism upon steam operation, and taking for contrast a line poorly equipped and badly worked, a very favorable case may be drawn up for the use of electricity.

A more rational assembling of the elements involved makes clear the present economic advantages through the use of steam. Except as a means of ventilation in tunnel operation or the luxury of passenger trains at large terminals, or in exceptional locations where traffic, physical, and economic conditions not only indicate but demand electric traction, I see no reason why the steam engine should not more than hold its own in the evolution of the future, if its natural guardians but do their duty.

It must always be kept in mind that hydro-electric power in any considerable quantity can only be generated in a small section in the extreme northwest, parts of the states of Montana, Idaho, Washington, Oregon, and California, in a still smaller section in the southern Appalachians, parts of the states of North and South Carolina, Tennessee, and Georgia, and in the Niagara-St. Lawrence region. Else-

where, and that means from a traffic viewpoint pretty much the whole country, hydro-electric power will not suffice to supply the local demand for lighting and traction purposes. We must then confine our attention to the generation of steam by the burning of fuel and that fuel, coal. For while some petroleum oil is used, its use as a substitute for coal is not extensive and seems likely never to be extensive. Even in the hydro-electric plants, there are extreme fluctuations between the minimum and maximum supply due to weather conditions, and nearly always auxiliary steam plants are necessary.

Present control of thermal efficiencies results in a percentage of effective power from combination internal combustion steam motors, it is claimed, as high as 40 to 45 per cent; in internal combustion engines from 25 to 30 per cent; at the switchboard of a modern steam electric central power station, from 18 to 19 per cent; at the drawbar of an electric locomotive, from 3 to 5 per cent; and at the drawbar of a steam locomotive, from 4 to 6 per cent.

There was a time when stationary engine practice was behind that of locomotive practice, but of late years very great improvements have been made, based upon changes in boiler pressures, which have risen from 125 to 150 pounds in 1898, to from 350 to 500 pounds in 1920, whereas the steam pressure in use on locomotive boilers has, since 1898, with few exceptions, remained practically stationary at from 200 to 220 pounds.

Since electricity is used as a means of transmitting the power generated in a stationary steam boiler, why is it not so cheap as to put the moving locomotive boiler out of business? The explanation of the relative efficiency of the steam and electric locomotives is that the steam locomotive uses the power from its engines through the direct-coupled main driving rods while the electric engine must use power generated at its power house, transmitted over long distances through an installation of great cost, of a capacity enabling it to take care of peak loads, with much opportunity for leaks and losses and with absorption of energy

through the control of motors through the rheostat and through the winding of the motors. The investment cost for hydro-electric power development per horse power produced is from three to four times that of a steam plant, while for a steam-electric power development plant the first cost is from five to ten times as great.

In working the Baltimore & Ohio Railroad's Mount Royal tunnel electrically (the first electrical railroad installation in this country, completed in 1895) the engine mile cost of the electric locomotive was about twice the engine mile cost of the steam locomotive and this ratio still generally obtains.

Think on George Westinghouse. At the age of twenty-two he brought out the first air brake; at twenty-five he patented the triple-valve, the device that, from its beginning, was and still remains the heart of the air brake systems, his greatest contribution, giving to America far and away the best braking apparatus and system in the world. At thirty-four he organized a switch and signal company and two years later installed the first power interlocking. At forty-two he patented the first friction draft gear, a type without which the heavy freight cars of to-day could not be handled, since the reaction, were springs alone available, would make their use impossible. His interests extended as well into the fields of steam turbine and gas engines; natural gas; and the alternating current method of transmission, and devices making possible the varied uses of electricity. In the history of American railroads there has been no more active and competent mind working on these problems, nor any working more successfully.

PART III

ORGANIZATION, FIELD AND STAFF

There is a soul to an army as well as to the individual man, and no general can accomplish the full work of his army unless he commands the soul of his men as well as their bodies and legs.—GENERAL SHERMAN.

General Wilson has been ordered to report to you. . . . I believe he will add 50 per cent to the effectiveness of your cavalry.—GENERAL GRANT to GENERAL SHERMAN, Oct. 4, 1864.

Masséna on the field of battle is worth an Army Corps.—NAPOLEON.

PART III

ORGANIZATION, FIELD AND STAFF

A corporation of the first magnitude and of the character of a railroad rests its hope of successful operation very largely upon organization, discipline, and continuity of employment.

At all times forms of organizations have swung between the extremes of great centralization and great decentralization, in the railroad service between the departmental and the divisional organization.

It must always be kept in mind that discipline contemplates two attitudes; the person disciplined may be a disciple, a learner; or he may be one subjected to punishment. Both relations contemplate knowledge, capacity, fair dealing, and resolute courage on the part of the officer charged with administering discipline. There is no more important function to discharge, nor one to which more care and thought should be given.

There must be such continuity of service as will insure a reasonable hope of advancement; and for the entire body a continuous policy; a history personal in its character; and an *esprit de corps* founded on mutual experience, respect, and confidence.

92. Organization.—The duties of the officers and men are laid down in part in the "Organization and By-laws" of the companies, in the "Book of Rules," in "General Notices," and in "Orders." It would seem to be advantageous if there could be some more general description of the organization and the underlying ideas giving rise to it, a standardization of the titles of all who find place on the pay rolls, with some description of their place in the organ-

ization, their duties, the line of their responsibility, and the authority for their oversight and action.

The organization provides the structure for the body. It coördinates the mutually connected and dependent parts and processes and forms them into a systematic, definite, and orderly structure, framed and put into working order for united action. By means of it there comes into being a body into which life is breathed, activity aroused, and motion given by the impulse of management. To be in any real sense effective it must enable responsibility to be fixed squarely upon a particular individual, and must provide power to make that individual pay the price of his shortcomings.

It must possess diversity to cope with the different problems presented to it by the industries, the regions, and the people which it serves, and it must have unity in order to be able to bring all its forces to bear on any particular problem. And this last has an importance not generally realized, for the whole is not merely the sum of all the parts, but the sum *plus* the interaction of the parts, regulating, inhibiting, multiplying ther effectiveness and force—a contribution of management.

The early English railroads were largely officered by men from the regular army and the organization reflected their experience. It remains to this day an extreme example of departmentalism. Under it the lines of authority and responsibility are sharply drawn and most of the power gets into the hands of the specialist. As the railroads were developed in other countries this organization was generally adopted. The laws of the State of Pennsylvania of June, 1836, regulating the duties and powers of the officers in charge of the state works, prescribe for the officers of its railroads substantially the same distribution of authority.

But with us the prevailing opinion has come to be that the divisional organization, with its great advantage of broader training and experience for the advancing officer, is the better. It is not believed that the consolidation of railway properties into large systems takes away to any great

extent the opportunity for the personal development of the subordinate officer. There is still ample scope for him to develop, to originate, and to advise; as heretofore, plenty of room for him to show of what stuff he is made.

If the competition is more intense, the reward is surer, the openings for promotion more numerous. The large enterprise offers a better school for training and development, and the chance for gaining a reputation that is impossible in a smaller field. Particularly is this held to be true of the division superintendent, who controls all the activities of his division, who is furnished with statements of earnings and expenses and can form his own opinion as to whether the things he wants can be afforded.

Figure 21 shows the generally accepted features of railroad organization, the portion in dispute being left blank. Figure 22 shows the typical departmental organization, and the application of the typical divisional organization to this disputed portion. It will be seen that with the exception of a relatively restricted area, the entire railroad organization continues on a strictly departmental basis.

The object sought is to secure as well as may be that unity of purpose, plan, and execution to be gained through centralized control, as well as the benefit of the specialized experience of the expert, and to coördinate them most effectively in the achievement of the aims inspired by broad vision.

Objections urged against the departmental organization are that in the preparation of a plan the designer, while far enough away to obtain the general view and perspective, is too far away to be able to conceive the detail; that at times conditions change rapidly and unless the designer is immediately at hand to modify the plan the work must stop, or, if kept going without modification of the plan, will not be adjusted to the changed conditions. It is urged that strength and weakness are best shown in emergencies; that in emergency the departmental plan shows very great weakness, because of the lack of authoritative coördination of forces. It is urged, moreover, that because of this lack there

is often weakness in the ordinary and regular course of procedure. The stock arguments against the departmental organization are that it involves a "divided responsibility"; that the officer or employee is responsible to two or more officers for the same thing; that differences of opinion as to the conduct of specialized phases of the work are of constant occurrence upon the several divisions, and that, unless there is an officer with authority to adjust these differences, the harmony and efficiency of working are impaired. It is further urged that when the common authority is far removed and without time to devote to such matters, there is difficulty in obtaining decisions in time to be of service. One result of this is that subordinate officers of departments are prone to neglect work that would greatly aid the other departments but does not redound to the apparent credit of the department that has to carry the burden of the cost.

The very fact that the operation of a railroad presents three distinct phases compels specialization in the conduct of these phases; departmentalism arises from specialization. For maintenance of way, maintenance of equipment, and conducting transportation there must be three sets of employees. The work of the employees of each set must be directed by an officer expert in that kind of work. There must be an engineer maintenance of way, a master mechanic, a train master. Here are the germs of the engineering department, the department of rolling equipment, and the department of transportation. There must be coördination as well as specialization. The question is at what point in the operating organization is it most desirable to vest that authority over the work of these three phases of operation which will best conduce to their effectiveness. Under the divisional organization that coördination is primarily vested in the division superintendent; under the departmental organization that coördination is primarily with the general manager or the vice-president in charge of operation.

There cannot be any hard and fast determination of this question for every railroad, under all circumstances. The kind of organization best adapted to the operation of a par-

ticular railroad will depend upon the conditions under which its operation must be conducted. On small properties, say with no more than six operating divisions, the departmental organization is the more economical and effective, though it is peculiarly dependent for its maximum success upon the location of the headquarters with relation to the administrative unit, and this is of far more importance than the number of units. The difficulties attending the designing and execution of plans in general may be met by the assignment of assistants to particular pieces of work, and reliance upon inspectors to correct irregularities or to meet changed conditions.

The handling of an emergency may be met by a rule that the head of the department most affected shall take authority over all forces on the ground, the division engineer in case of a washout, the trainmaster in case of a wreck, and that this authority shall extend back to the points from which the several forces and materials are marshaled. The operating department of a railroad must be prepared to meet, without confusion, two classes of occurrences, ordinary, as well as emergency, and the important test of its strength or weakness comes not in its ability to cope with an occasional casualty in a little less time than ordinarily required, but, on the contrary, in its ability to meet the extremes of prosperity and adversity to the best advantage of efficiency in the service of transportation and the stockholders. Financial straits at times require the prompt control and suppression of avoidable or deferable expenditures and the concentration of available resources upon vital requirements; the more acute this need, the greater becomes the necessity to work closely to one central plan.

Again, at the crest of a boom, the demands of traffic are such as usually strain to the utmost the facilities, equipment, and personnel, while the pressure to secure the maximum operating economy is, and must be, relaxed. The organization that can successfully adapt itself to these extremes is not easily to be disconcerted by an occasional call to meet casualty emergencies.

As to "divided responsibility," it is an example of the use of words to which different meanings attach. Many cases of so-called "divided responsibility" are to be found under both plans of organization. Responsibility is not in fact "divided" in the sense reprehended; that is, that the officer or employee is responsible to two or more officers for the same thing. Rather it is "distributed"; that is, an officer or employee may be equally responsible to two or more officers each in his own jurisdiction and to each for different things. Skillfully prepared regulations will establish proper relations between the departments even at points so remote from headquarters as an outlying division, and where the officer in common control of the several departments has not time to keep in touch with a disturbed situation, he might well utilize machinery analogous to that of the United States Navy organization with its division of inspection and its board of inspection and survey for ships and for shore stations, and its special inspecting officers. The mail and the telegraph eliminate time as an obstacle in bringing matters of importance to the attention of the chief. Finally, as to one department protecting itself at the expense of another, it is no doubt true that no man is greatly given to the practice of advertising his own failures, whether he be a division department head or a division superintendent in charge of all departments. The tendency consequently is, in case of the divisional organization, to suppress reports to the general officers of those minor casualties that are constantly occurring on the best of railroads, whereas under the departmental organization, the tendency is rather to exaggerate the importance of such happenings as tending to explain why the department not responsible was unable to obtain better results. Thus, while tending to reflect on the efficiency of the departmental organization, in reality it results in showing up more clearly the actual conditions and enabling steps to be taken for their correction.

The chief defects of the "two-Czar" system (the division superintendent and the general manager), as the divisional organization is sometimes disparagingly called, are the diffi-

culty of preventing the office of general superintendent from becoming one of mere record and reference, and the danger that both the "Czars" will neglect "transportation," the heart and soul of the business, and be lured into and lost in the fields of maintenance. In planning, the divisional organization is in an advantageous position to fill in the details but too close to them to be so well able to grasp the relation of the parts to the whole.

The temptation is great for the divisional officer to raise higher and higher the standard of perfection in maintenance, greatly increasing its cost. As a matter of fact, there is always full recognition that only the exceptional division superintendent can be an expert in more than one or two branches of the service. But the advantage of vesting authority in the man-on-the-ground is very compelling. As a consequence, orderliness is sacrificed to strength, and the division superintendent in responsible charge leans heavily on the staff experts of the general manager for such aid as he requires.

The practice under both systems is weakened by the tendency of officers, when promoted, to take over with them to their new positions many of the duties of the old ones, partly from habit and partly from a feeling that they can more efficiently handle them than can their successors. It is a tendency that should be carefully guarded against.

One of the unfortunate consequences of the working of the Interstate Commerce Commission, United States Railroad Labor Board, Public Service Commissions, etc., has been to throw upon the official staff of the railroads the preparation of a vast amount of detailed information for the use of these bodies and to place the officers in a defensive position with respect to their conduct and practice, and, true to the character of bureaucratic institutions, this has increased with a mushroom growth until now a very substantial portion of the time of the entire official and sub-official staff is devoted to furnishing detailed information or to building up evidence with which to defend the properties against anticipated criticism. There are few things that would so

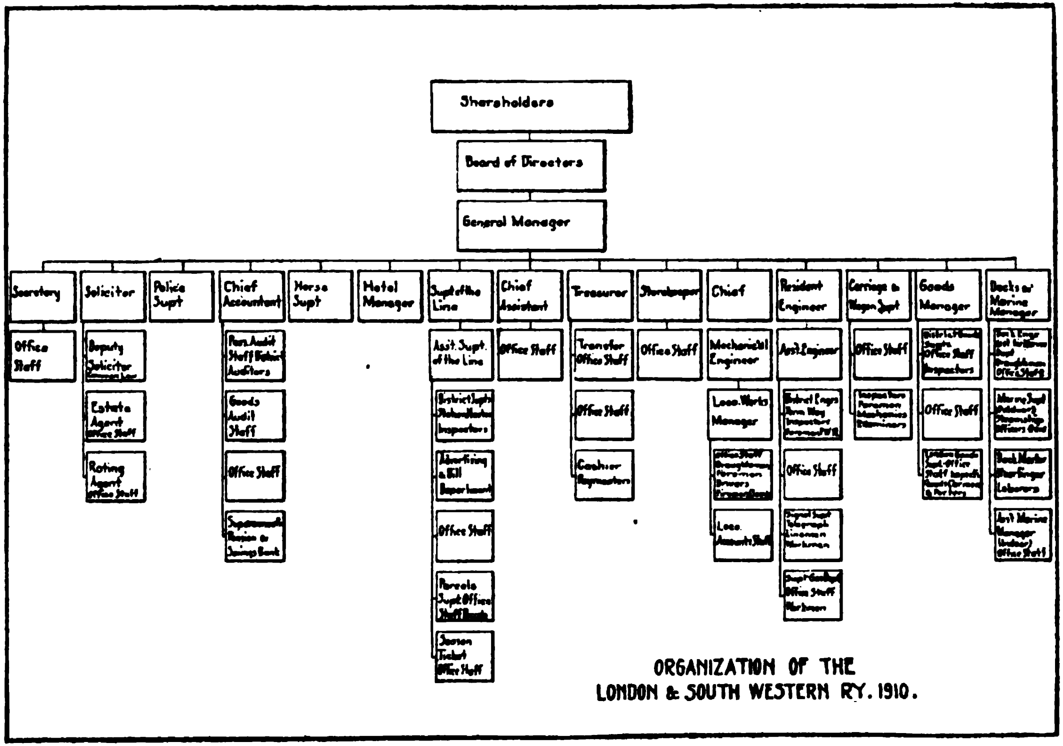

FIG. 20.—ORGANIZATION OF THE LONDON AND SOUTH WESTERN RAILWAY.

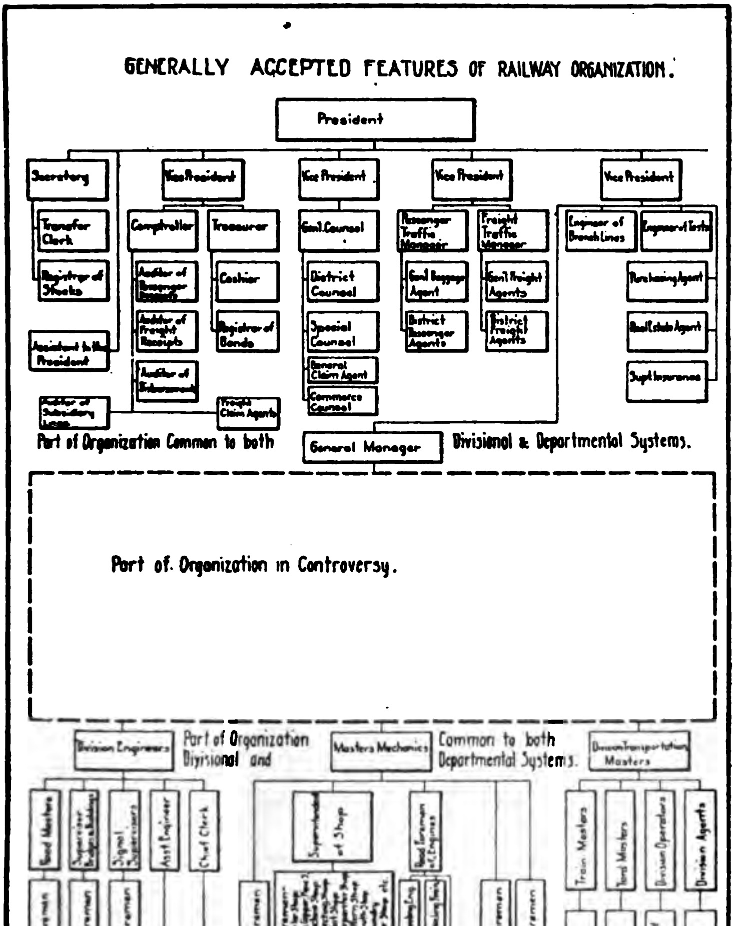

FIG. 21.—RAILWAY ORGANIZATION.

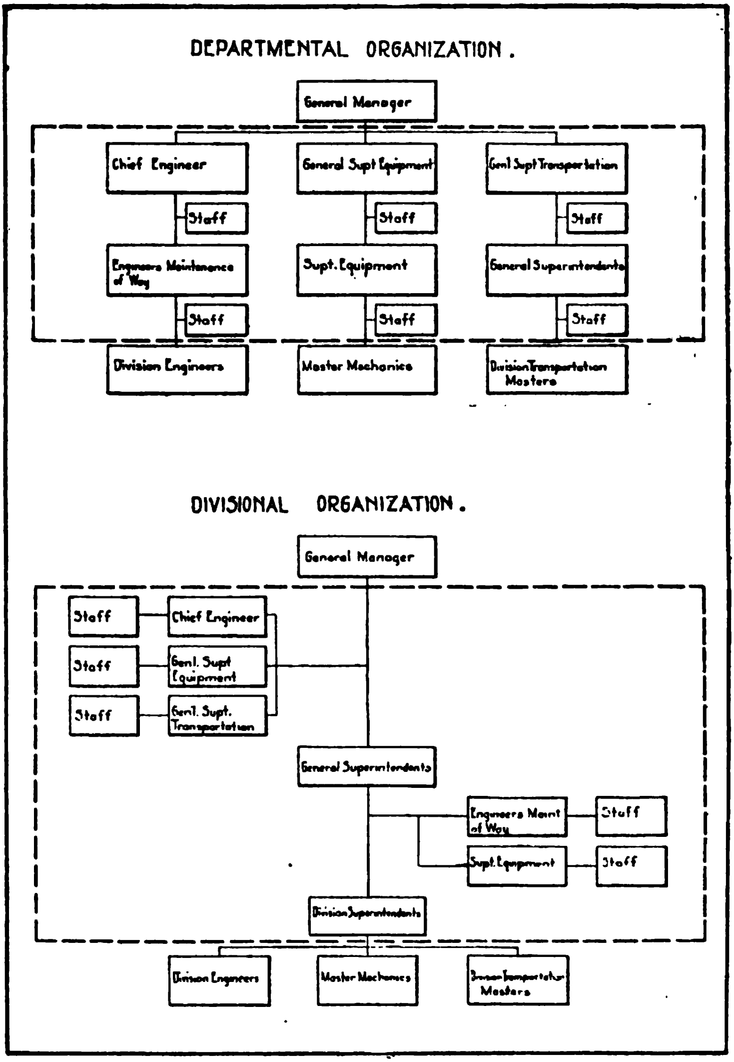

FIG. 22.—DEPARTMENTAL AND DIVISIONAL ORGANIZATION.

immediately react to improve the service as well as to restore a more wholesome mental attitude than by finding some way to give the supervising personnel more time for consideration of the problems of moving the traffic and developing or extending the business.

In writing of the officers I have drawn attention only to their transportation duties and have freely availed myself

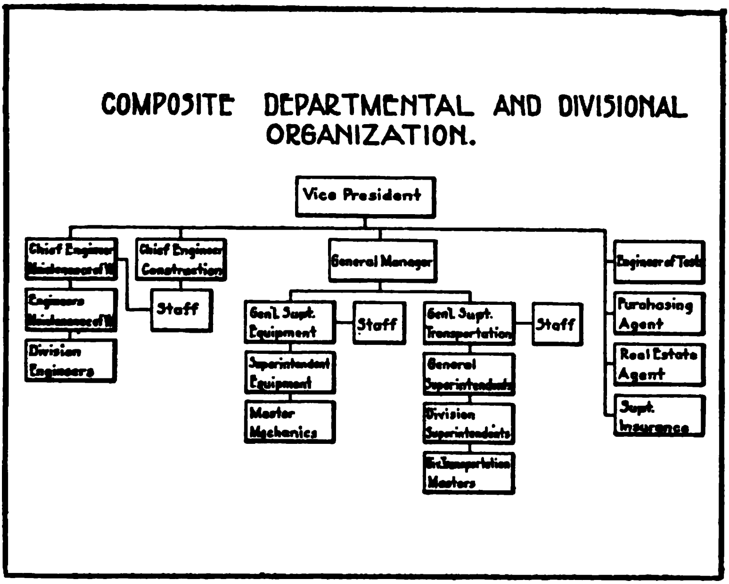

Fig. 23.—Composite Organization.

of information from the Pennsylvania *Organization; Railroad Administration* by Ray Morris; *Yards and Terminals* by Droedge; *The Train Wire* by Anderson, and other sources. The discussion will be aided by a study of Figures 20 to 26, inclusive. Some of the minor officers are given extended notice, but this is because their offices are comparatively new.

The reputation of the railroad with its patrons and neighbors is made very largely by the division superintendent, station agent, passenger conductor, yardmaster, and section

foreman with all of whom they have personal contact. For many things these men should be given authority and trained to use it; to say "yes" and "no" promptly, considerately, and courteously to questions arising in the line of

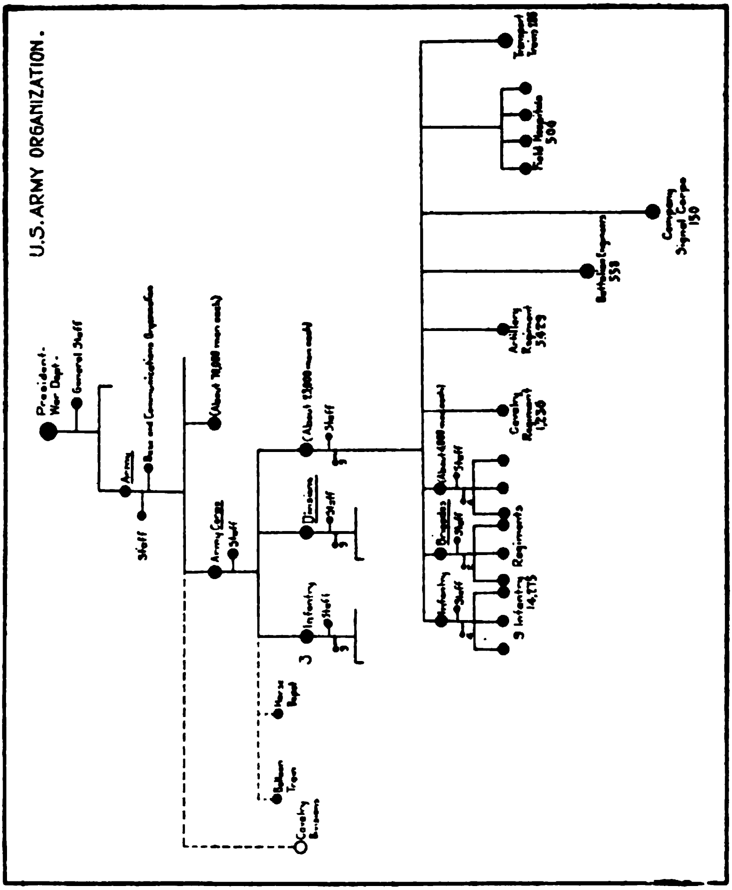

FIG. 24.—UNITED STATES ARMY ORGANIZATION.

their duties; to be to the public what the public looks upon them to be, the incarnation of the company itself in the respective fields of their activities.

93. The General Manager.—The duties of the General Manager differ in scope on different roads. On all roads he is in direct charge of operation and receives reports from

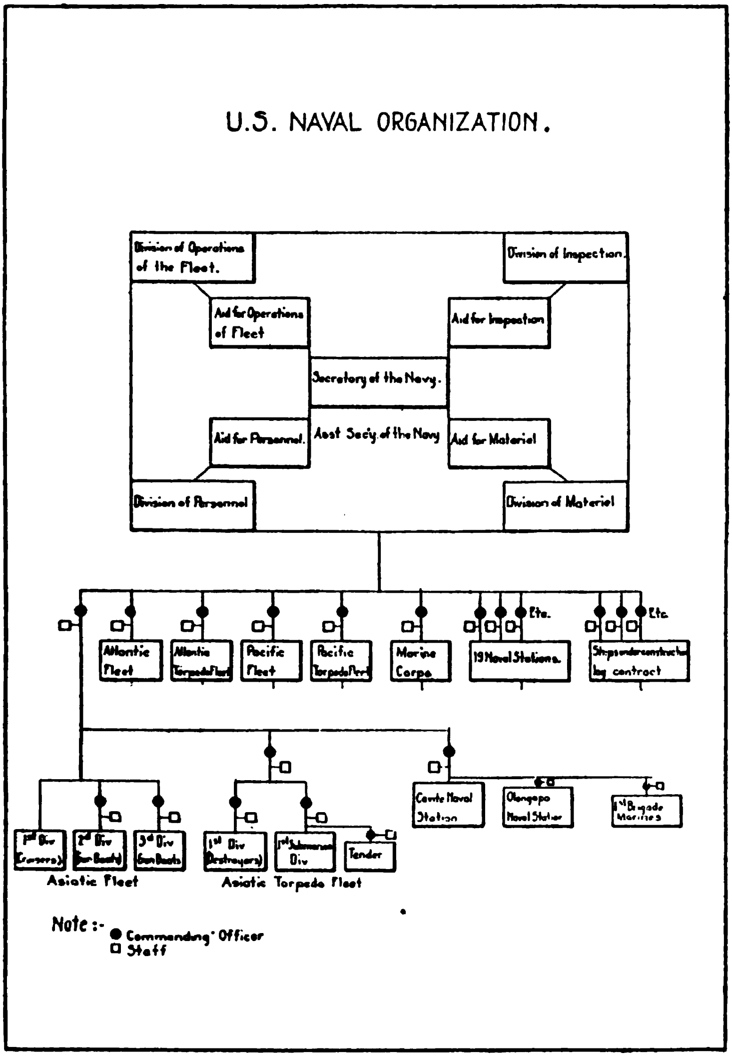

FIG. 25.—UNITED STATES NAVAL ORGANIZATION.

the general superintendents, who, in turn, act through the division superintendents. Thus he controls all train movements, and is the responsible authority in cases of delays, wrecks, great storms, or of special demands on the com-

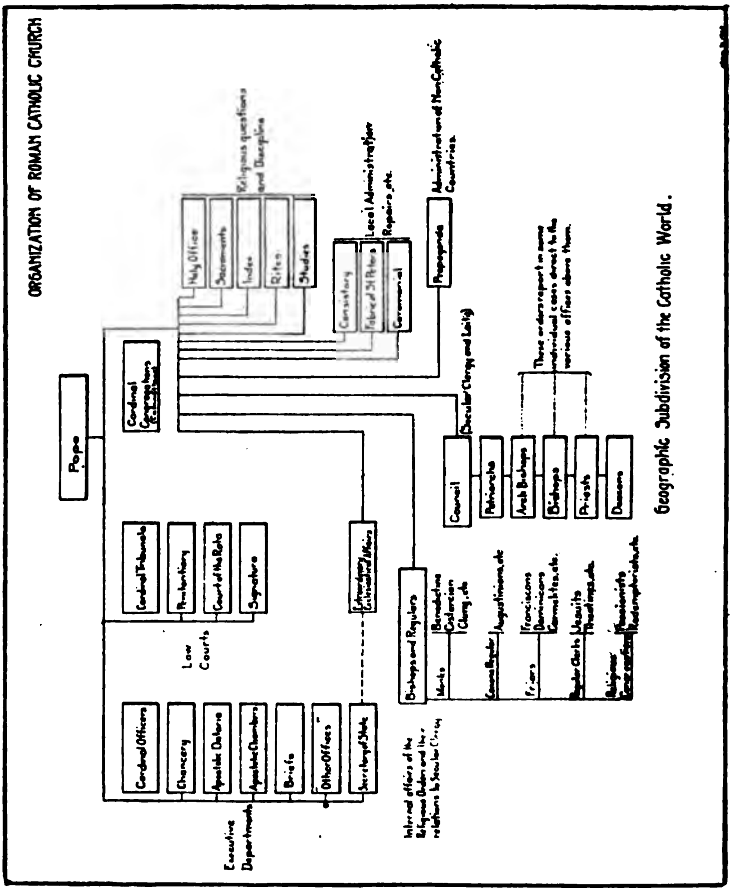

FIG. 26.—ORGANIZATION OF ROMAN CATHOLIC CHURCH.

pany's facilities. He is also the arbiter of the more important difficulties with labor. This is a task of the highest delicacy, which at certain crises occupies more of the general manager's thoughts and occasions him more worry than all his other responsibilities together. He is responsible for

the safe and economical management of the road. He prepares the necessary rules for the government of his department. He appoints its subordinate officers, and is responsible for discipline among its employees. He estimates the requirements of the road for rolling stock, both in quantity and design. He estimates the development of the property in general that will be requisite to provide for the continuing growth of its traffic, and for improvements and economies in operation. In the varied and numerous matters involved, it is idle for the chief executive officer to attempt much knowledge of details. The foundation of sound railroad management lies in attention to the general interests of the institution and in the selection of men in charge of each department of the service, competent and faithful to carry out in the most efficient manner their respective duties. All his examination of details should be with reference to knowing how far he has been successful in this feature of his administration.

The Staff.—The general manager (or on large properties the vice-president in charge of operations) is the only officer on the railroad who has any considerable staff.

Besides the line officers, the general manager is likely to have, directly engaged in transportation and reporting directly to him, a general superintendent, chief engineer, engineer maintenance of way, signal engineer, real estate agent, superintendent of motive power, master car builder, engineer of tests, superintendent of telegraph, chief claim agent, insurance agent, fire inspector, general fuel agent, purchasing agent, superintendent of stores, dining car superintendent, industrial agent, superintendent of car service, superintendent of personnel, superintendent of police, superintendent of safety, chief surgeon, and manager of marine department.

In the staff, in its make-up, the division of its activities, the character and disposition of its officers, the scope and practice of their powers, lie large opportunities for success or trouble.

A staff unnecessarily large is apt to seek occupation in

every objectionable way conceivable. The vain are dissatisfied, the ambitious tempted to intrigue, the idle hands are put to mischief. The smallest staff practicable and the hardest of hard work make for the greatest security. An alternation of line and staff duty tends to the efficiency of both services, and such a practice might find useful extension by giving men an opportunity to serve for short terms on the many committees and organizations and in activities where a broad view of a region or even of the whole country may be had and the practice of other roads studied.

The organization of the Imperial Russian Railways alone appears to have included an inspector general with duties corresponding to those of an officer of that title in army service. Many attempts have been made in this country to work out a similar service, which has much to commend it, but so far without the establishment of any permanent practice.

But the opportunities of the staff go along with the dangers. The operations of a railroad embrace such a multitude of varied detail that no individual has the time or the physical strength to give them all personal supervision. For attention to these details the general manager must depend upon the staff, which is to the railroad organization what steam is to the locomotive, the instrument through which he transmits energy and direction. A knowledge of human nature is half of the matter and finds a field as important in the governance of the staff as of the working forces.

Staff meetings have been held on some roads from an early date. These are, as a rule, attended also by some of the division officers. The bringing together at headquarters of all officers, at regular intervals, forms a valuable feature in the operation of the property. Thus they have the opportunities of personal acquaintance, exchange of experiences, and comparison of notes, as well as contact with the chief operating officers, from whom advice and instruction may be had on important and perhaps delicate matters, while these officers, through contact with the men who are engaged from day to day in supervising the actual operations, are thus

kept advised of everything that is going on on the property.

Another important staff duty is the system of periodical inspections through which a zealous watchfulness is exercised to insure that all the necessary precautions dictated by experience and laid down by authority are thoroughly and effectually observed.

These periodical meetings and inspections, with the systematic examinations and instructions in the "Book of Rules," the "Instructions to Agents," the "Use of Signals," "Air Brakes," etc., keep the entire force interested and attentive. From the very bottom each may contemplate a field of possible promotion as wide as the service itself, meantime receiving a compensation adequate for comfortable support and assured of continuous employment.

94. General Superintendent.—When operating units of the railroad grouped together for general supervision become large enough, they are usually put under the control of a general superintendent. His management involves arduous and important details, calling for large business experience and qualifications in judging of men and things.

The work of the general superintendent is very laborious, since he gets all the hardest problems of all his superintendents and what may be called the primary and direct responsibility of a larger district than any one else concerned in operating the railroad. He must of necessity spend a great deal of his time on the road and must keep in constant touch, not only with his division superintendents, but with their subordinates, the roadmasters, master mechanics, train masters and dispatchers, in order to form his own opinions of the conduct of the company's business. Not the least demand on his skill is the matter of promotions.

95. Superintendent Car Service.—The superintendent car service, car accountant, or superintendent transportation, keeps track of all freight cars on the line at all times, and of his company's cars off the line. Every freight car that comes on the company's tracks or goes off them to somebody else's tracks must be recorded by number and by the owner's initials, in order that the balance for "hire of

equipment" may be promptly adjusted and the exact location and distribution of cars known to the general manager. He should equalize the changing needs of different parts of the system by supervising large car movements from regions where cars are at the moment abundant to regions where cars are temporarily scarce. The actual process of collecting the information about freight cars is a work of great detail, involving the employment of many men, but its principles are simple.

96. Superintendent of Personnel.—The superintendent of personnel should be attached to the staff of the general manager. This has a tendency to create a feeling of respect for the position among the employees and gives it the dignity necessary to do business with other officials.

While the scope of the position should be to a degree advisory, his counsel should be respected in matters relating to employment, rates of pay, and working agreements. The action suggested will be based on established precedents and past practices which it is considered advisable to protect in the interest of uniformity in operation or for other reasons.

He should make exhaustive studies of all local and general agreements governing wages and working conditions, closely observe the operation of the various rules, with the object of inducing a uniform application at all points, interpret obscure sections, and, when necessary, prepare instructions for the correct application when departments or divisions diverge from the true intent of any of the provisions of such agreements.

He should be consulted when local agreements governing peculiar conditions are contemplated, and should constantly guard against the establishment of practices, of either a local or general nature, that might result in restrictions of operation. He should be available at all times to employees and officers concerning matters in dispute, grievances, interpretation of obscure sections of working schedules, and the like. He should endeavor to consider judicially, without bias or prejudice, contested questions that are brought to his attention and when, in his opinion, the facts sustain the conten-

tion of the employees, he should place his findings before the officer who was responsible for the error of judgment in order that a repetition may be avoided and the necessary adjustment made. When his investigation reveals that the employees' claim is unreasonable or ill-founded, he should acquaint the employees' representatives with the facts, clearly and explicitly, to remove any doubt from their minds as to the justice of the position the management assumes.

Some railroads have defined certain channels through which employees' grievances must pass, and have organized permanent committees, composed of operating officials, for final consideration of such grievances after they have been handled without adjustment through the prescribed channels up to the highest divisional head. In his capacity as advisor the superintendent of personnel will have opportunity to acquaint himself with the facts in the more serious cases from the time they are first presented, and, when they finally reach the officers' committee, he is fully conversant with all angles of the disputed cases and can explain and offer advice or suggestions to the other members of the committee. This plan relieves operating officers of the necessity of investigating details of such cases with the attendant loss of time, and enables them to devote a larger portion of their attention to actual operation.

He should study the wage structure and working agreements in operation on connecting railroads and in industries adjacent to the railroad. He should conduct negotiations when representatives of the employees present requests for changed working conditions or increased rates of pay. He should be assisted in such negotiations by the operating officers whom the general manager may designate.

He should maintain records of authorized rates of wages in effect at all points and in all departments on the railroad, and should be prepared to furnish comparisons. He should be charged with the responsibility of preventing unauthorized departures from established rates that might create inequalities in payments for similar services. He should investigate the necessity for recommended adjustments in

rates, increases in normal force, and acquaint the general manager with his findings.

He should be prepared to represent the general manager at all conferences with officials of other railroads, industries, boards, etc., for consideration of revisions in agreements covering wages and rules governing working conditions with employees, and related subjects.

Another important duty of the superintendent of personnel is the supervision of employment, and his approval should be required before applicants are permanently employed. In this capacity he should pass on the various physical and mental examinations to which applicants for employment are subjected before their permanent employment is authorized. He should be charged with the investigation of applicants' service records with previous employers, and should also make inquiries concerning their character, ability, etc., in the towns where they have resided or were employed. His advice should be sought when changes are contemplated in supervisory positions and before men are selected to fill newly created positions of this character.

He should maintain a file containing a complete and accurate service record of every employee. All promotions, transfers, resignations, dismissals, leaves of absence, assessments of discipline, etc., should be reported to him as they occur. These data should be indicated on service records in order that they may be maintained currently.

His records should instantly show the normal force at any point or in any department, arranged occupationally, with number, names, occupations, etc., of employees under each foreman, hours of assignments, turnover percentages, and reasons therefor; they should answer, in short, any question that may be raised concerning the personnel of the railroad.

He should conduct an employment bureau, classify applications for employment, investigate the sources of labor supply, and be prepared to assist in filling vacancies as they occur. The division officials, however, should be directly

charged with the responsibility of securing sufficient labor to prevent interruption of operation.

He should investigate the facilities and operation of railroad Y. M. C. A. buildings located on the system where employees are accommodated when the service compels their absence from home terminals.

He should supervise the actual operation of barracks, restaurants, sleeping quarters, and rest rooms that may be maintained for the accommodation of employees.

He should supervise the equipment and operation of camps for the housing and feeding of casual labor when the exigencies of the service demand that type of help, and the operation of boarding camps used by traveling gangs. He should take measures to insure that proper sanitary precautions are observed, outline plans for the economical operation of commissaries, and record the cost of operation. Requisitions for additional equipment of this nature should bear his approval before purchase is authorized.

He should direct the detail work incident to pension, benefit, and welfare plans.

In brief, the superintendent of personnel should be an authority on the provisions of all wage and working agreements; he should exercise jurisdiction over employment, and his constant ambition should be to increase efficiency through the medium of a harmonious coördination between the employees and the management.

On many railroads this officer is assuming a position of major importance. He should constantly study the problem of how best to provide and perpetuate an official staff to conduct the management of the enterprise, and to infuse into that staff from top to bottom a spirit of loyalty, not only to the purpose of the enterprise and to the policies adopted to carry it out, but also to the officers who form the policies and transmit them. Above all, his aim is to create and maintain *esprit de corps,* a spirit of team play in the entire organization, the officers both of the staff and line, and the men.

97. Superintendent of Safety.—The superintendent of safety makes detailed inspections of shops, machinery, tools,

appliances, rolling stock, stations, yards, bridges, tracks, etc., for the purpose of locating unsafe conditions. He observes working methods and practices, bringing faults to the attention of the local officer in charge, or to the proper departmental head, for consideration and correction.

Other measures taken by the superintendent of safety and his staff to stimulate and sustain interest in accident prevention are to:

1. Keep an authentic classified record of all personal injuries which may be drawn on for the instruction and warning of employees.
2. Give frequent talks to employees on safety, urging them to exercise care in the performance of their respective duties that personal injuries may be averted.
3. Issue safety bulletins for the information of officers and employees generally.
4. Prepare statistics and other data for the information and guidance of safety committees.
5. Attend division and shop safety committee meetings.
6. Review reports of all safety committee meetings for the purpose of:
   (*a*) Making proper acknowledgment to the chairman of the committee submitting the report. Commending and criticising the work of the committee and its individual members.
   (*b*) Checking closely the business of the meeting to see that recommendations are properly handled without unnecessary delay.
7. Attend all meetings of the general safety committee, acting as its secretary, preparing the agenda, sending out the notices of the meetings, and supervising the preparation and distribution of the minutes, etc.
8. Arouse and sustain interest in accident prevention and measures intended to reduce the hazards incident to railroad operation.

The method commonly used of arousing interest is to hold public safety rallies at the larger centers attended by officers and employees and their families. At these rallies motion pictures illustrating conditions and practices that most frequently cause personal injury are shown. Addresses are made by local officers, and the aims and purposes of the safety movement fully explained by the superintendent of safety. It is also customary to include some entertainment, such as music and singing.

After interest has been aroused, safety committees are organized on each division and at the larger shops. These committees are composed of the local officers and employee representatives from each branch of the service affected. Each committee has a chairman who is the highest local officer; the superintendents being chairmen of the division safety committees, and the master mechanics or divisional car foremen chairmen of the shop safety committees. The employee members of the committees are appointed by the chairmen for periods of six months. At the end of six months, after the first committee has been organized, and each succeeding month thereafter, the chairman appoints from the same branches of the service such a number of new six-month service members, necessary to fill the vacancies, as will bring about a complete change of membership every six months. A member whose term of office has expired becomes an honorary member of the committee. The committees meet once a month, at which time each member reports any unsafe conditions or practices which he has noted, and offers suggestions for their correction. Items that can be and should be corrected are corrected by the local officers, if within their authority. If not, they are reported to the officer who has jurisdiction. These committees aid in stimulating and sustaining interest. Each member is required to make a monthly report showing individual activities and accomplishments during the period between meetings. On these reports appear the items, both conditions and practices, corrected or warned against; the reports are read aloud at the regular meetings after which they are handed to the chairman for forwarding to the superintendent of safety.

Booklets outlining the safety committee organization and suggestions for the prevention of accidents and pamphlets of instructions to members of division and shop safety committees are supplied to all committeemen.

Periodical reports are made to the general manager giving details of work accomplished.

98. Police Service.—Following the Civil War and the depression in business after the panic of 1873, there devel-

oped a number of persons unemployed and unemployable, who moved about from place to place supporting themselves by begging and petty thievery, popularly known as tramps. Their ranks were constantly recruited from discouraged thieves and other criminals. The hordes were much in evidence around railroad yards and water tanks and freight trains until the beginning of this century.

As a division superintendent I became interested in freeing the property of my division from this nuisance and menace, and developed a police force for the service which, working continuously on a thought-out plan, accomplished its object. Later, as general manager, I expanded the force to cover the entire property and increased and systematized its duties. This police service was organized to protect the property of the company against carelessness, negligence, malicious mischief, depredations, and fire; to guard travelers against pickpockets, thieves, and gamblers; to guard the traffic from theft or "loss and damage"; to assist in gathering facts in cases of personal injury or other claims; to preserve order upon the premises of the company and upon its trains; to aid in quelling disturbances that might arise; and to uphold and enforce the law in so far as the company's interests might be involved.

The service consisted of a superintendent of police, inspectors, captains, lieutenants, patrolmen and watchmen. The superintendent was in general charge, and the inspectors reported to and received their instructions from him and acted as his assistants.

The captain of police is a division officer responsible for the proper guarding against depredation, fire, or trespass upon the company's property or that entrusted to it. He maintains order at stations and in yards, assists the conductor in maintaining order on trains, and furnishes protection for the pay car. He investigates all burglaries, robberies, and other crime in which the company's interests may be involved and uses every endeavor to apprehend the perpetrators. He keeps a record of arrests and a property book with a complete description and account of all prop-

erty, money, or other valuables that may be reported stolen, of all property recovered and its final disposition. He must be familiar with the state laws and municipal ordinances affecting the railroads.

He has the supervision of the men of his force, arranges and lays out their work, instructs them regarding it, stations them at such places and assigns them such duties as he may deem expedient. He must know from personal knowledge that their duties are properly performed and that they understand the rules and regulations. At suitable times he calls them together for inspection and instruction.

He makes and transmits all reports of the operation of the police service on his division and is responsible for the issue, use, and return of all clubs, badges, and other equipment issued.

99. Division Superintendent.—The division superintendent is immediately responsible for the proper movement of cars and trains and the economical administration of the business of his division. One man can personally supervise from 100 to 500 miles of road, depending upon the volume of traffic; divisions are usually from 200 to 400 miles long.

The division superintendent is expected to know everything, and is not supposed to need any sleep. He must be ready at any hour, day or night, to go to any part of his district where there is trouble, and to go there quickly, and he will almost invariably have to take the first authoritative action, in the case of fire, or flood, or strike, or train wreck, although he will keep headquarters fully advised by wire of what he is doing. In a crisis, questions concerning his authority seldom arise in any organization; he is supposed to be the strong, responsible man on the ground, no matter what happens. The division superintendent should be entrusted with very considerable discretionary powers in dealing with the people among whom he lives and with whom he is in daily communication, and should be held up to the public as the immediate authority in all matters of enduring interest to them and invested with power corresponding with

that position. It is a mistake to make him a mere link in a chain of officials propelled by motive power a thousand miles away.

Among the most important of the executive functions of the division superintendent is discipline, and it is one that, except in minor matters, should not be delegated to the trainmaster nor to any other subordinate officer. The superintendent should know better than any man in the division the rules of operation and the consequences of disobeying them. He should patiently investigate in person the causes leading up to every accident and apply the preventive remedy without fear or favor. He is the best judge of the discipline suited to each particular case. He must take care to get past appearances down to realities; and in dealing with his men he must keep in mind the difference, the very searching distinction, between reputation and character. He must study the relations of cause and effect. They are seldom sharply distinct but flow together as a stream, the effect of a preceding cause being itself the cause of a succeeding effect, and frequently the proper relations are difficult to ascertain. The situation is much helped by the fine attitude of the men and their habit of truthfulness and frankness in investigations.

Of great importance also is the spirit of loyalty, and for the encouragement of this spirit the division superintendent is in a particularly advantageous position. The thing that enables an organization to function in security is loyalty. There must be loyalty, not only to the company and to the service in general, but to each immediate superior officer. Every officer of every grade is justly entitled to the cordial support of each of his subordinates. He will deserve it if he respects their office himself and demands that respect from others. Without it no management can be successful. The immediate superior is the one most competent to judge of the qualifications of his men and he will be the first to speak the good word that so often turns the scale when promotions are considered.

I have served in a great variety of positions in the rail-

road service from rodman to president. I have always felt that the most desirable of them all, certainly in the vigor of life, is that of division superintendent. Here one knows personally his subordinate officers and men, their character, disposition, and conditions, their ambitions, hopes, and fears; he knows the customers of the road, their strength and weakness, prosperity or decline; here he can originate projects and follow them through to completion. Under the divisional organization especially he is more nearly master of the situation and of his own fate than in any other office in the service.

In the joy of the action lies the sense of any action. The ground of a man's joy is hard to hit, but to miss the joy is to miss all. Nowhere, I think, may that joy be so successfully sought out as in the activities, the power, and the responsibilities of the division superintendent.

100. Train Master.—The train master is an outside man. He has no office duties of consequence, but is expected to keep on the road almost constantly, observing locomotive performance under service conditions, studying the work of the trainmen and forming opinions about their fitness, and acting generally as the eyes and ears of the division superintendent. He must be an optimist and a diplomat to handle the independent crowd who serve under him. No matter how serious the situation, he must not show fear or nervousness. Should he show anxiety or confusion, his men will become alarmed and lose confidence. If he demonstrates his ability to do the right thing at the right time, they trust him implicitly. He only can resist their wiles, which are many, by the calmness of his demeanor, and retain their confidence by undoubted ability. The work of the mechanical department and of the transportation department are intimately allied, and the train master is the expert observer for both, although reporting to the division superintendent. The units of the transportation service are the station force, the yard crew, and the train crew. Sometimes all and always two of these fall under his immediate control.

Assistant train masters, in the performance of their

duties in the districts assigned, often have the same authority as the train master. On many roads they are the outside men, the train master handling from his office the movement of the traffic, the instruction, examination, and discipline of the men.

101. **Master Mechanic.**—Each large railroad shop is in direct charge of a master mechanic. He is the officer directly responsible for all local repair work, reporting to the superintendent of motive power on standard designs and methods, and to the superintendent, general superintendent, or general manager on the daily requirements of the operating department. He is assisted by a shop foreman, who conveys his instructions to the force of mechanics, carpenters, helpers, etc., and sees that they are carried out. He is also assisted by a roundhouse foreman and consults directly with a road foreman of engines, whose duties overlap those of the trainmaster on the mechanical side of operations.

102. **Engine-house Foreman.**—The engine-house foreman reports to the master mechanic, and, under his direction, sees that the engine-house is kept clean and in good order; that the workmen perform their duties; that the supplies are economically used; that the engines are prepared for service promptly and that they are in good working order and properly equipped; that they are inspected and cleaned and reported for repairs when necessary; and that enginemen and firemen are ready for duty at the required time.

He must comply with the orders of the road foreman of engines with regard to the assignment of engines and enginemen and firemen.

103. **Road Foreman of Engines.**—The road foreman of engines reports to the superintendent. It is his duty to ride on engines; instruct enginemen and firemen in the performance of their duties and in the economical use of fuel and stores; see that engines are in good working order and properly equipped; know the proper tonnage rating for each class of engine and report if more or less than this tonnage is given them; familiarize himself with the qualifications of

enginemen and firemen; and report any violation of rules or neglect of duty which may come to his knowledge.

He must consult with the master mechanic and engine-house foreman respecting the condition and requirements of the engines.

104. Yardmaster.—The yardmaster leads an eventful life, one that requires alertness, precision, and accuracy. Thousands of cars, occasionally broken and always breakable, come in irregular flow. Every unusual incident hinders him, but none helps him, for his work is movement, his danger is blockade. Always the cars are to go forward, for his bailiwick is simply a part of the main-line movement, slightly expanded for his work of breaking up and marshaling trains.

A blockaded yard means a blocked road, an absolutely useless, expensive tool, and this the yardmaster can make in a day, not necessarily by doing the wrong thing, but by not doing enough. Nor can he merely watch and wait; this is fatal; he must do something vigorously and keep going without admitting an impossibility. The ideal man for this work should have an aptitude and ingenuity for meeting small and great emergencies, something quite beyond the ability to follow rules. In a big terminal the difference in value between a good yardmaster and a poor one may amount to a president's salary. The yardmaster who is competent to handle a difficult situation is not always estimated at his full value.

The yardmaster should keep a log of the ordinary accidents, unusual weather, inability to obtain necessary road or yard power, injuries to employees, obstructions on track, in fact, anything that interferes with the smooth working of the yard.

To gain and hold the support of his men, the yardmaster must have their confidence and respect. This will be given him if he is a man of good character and knows his business. In manner he should be quiet and unassuming, but in conduct just and firm. When the position of yardmaster has been satisfactorily filled things move smoothly. The yard-

master, like the general in command of an army, must above all things retain his composure and control his temper, if only for the effect on his subordinates. Little can be expected of men during disturbed times when they see their leader "rattled" and going about in an excited manner, talking and gesticulating wildly. The habit of suppressing visible signs of emotion or chagrin may be difficult to acquire but it is one that should be cultivated.

The yardmaster must have his organization in such shape as to require but a small proportion of his time to be spent indoors. He should have a free hand to come and go at will, and occupy his mind with the larger and broader proposition, while not overlooking the smaller. It is his duty, and, during the season when his yard is heavily taxed, his salvation, to know all he can possibly learn in advance of heavy and unusual train movements to prevent being caught in a state of unpreparedness. Close scrutiny of the work at a transfer station, a manufacturing plant, a shop yard, may develop a feasible and advantageous change in his plans. Consolidation with other work will sometimes make possible a saving of half a day's work of a locomotive, a slight change in the track layout, or the addition of a switch or two in the yard of some private industry may make possible a reduction in locomotive service. Frequent interviews with the managers of the manufacturing plants and other industries requiring special switching service will often suggest plans whereby work may be cut out to the benefit of both corporations.

An inefficient officer cannot succeed; one who is competent cannot succeed without the coöperation of his fellow workers. The spirit of "the company for all, all for the company" is an essential to success as are the two rails upon which the wheels roll. In such an intricate undertaking as the working of a large yard organization, method and system are indispensable.

105. Division Operator.—In many important respects and in all matters associated with the management of the trains, the division operator is the right-hand man of the

superintendent. A suitable recognition of the importance of the position will have a valuable effect in elevating the character of the train service and in promoting its efficiency.

The telegraph and telephone may be viewed as holding to the railroad relations analogous to that of the nervous system to the body. From the center of intelligence and authority they carry information and instructions to every member. They keep in motion the whole body, which, without this, would be in a measure lifeless. Their ceaseless and healthful activity is all important, and as a failure of the nervous energy is to the human frame, so to the railroad is a falling off in the vital force operating through the train wire

106. Chief Dispatcher.—The chief dispatcher frequently acts as car distributor for his district. He compiles at a fixed hour each day, from information furnished over the wire by the station agents, a statement of the number of loaded cars awaiting movement in each direction, the number held for unloading, and the number and classes of empties, the number of cars requiring loading, their destination, and other information necessary to form a judgment. He should keep well advised as to seasonal movements and their amounts, as of fruits, vegetables, etc., and should have a painstaking estimate, obtained through several hands and estimated in various ways, of the real capacity for car loading of coal mines and industrial plants of different kinds. It would be well for him to keep a schedule of his final estimate in his office where it should be open to the inspection of all shippers, many of whom are extremely jealous and suspicious of each other and prone greatly to exaggerate their own capacities. He should, too, keep constantly in mind that a car is not simply a car. Its ownership should be respected, its capacity and class economically utilized. Not only will a highly intelligent discharge of these duties bring great returns to his company, but it will give a sense of security, confidence, and satisfaction to the shippers that will be a tower of strength in time of trouble. He should carefully study the government and local weather reports

and make frequent readjustments of the tonnage rating as these conditions make it necessary.

107. Train Dispatcher.—The train dispatcher holds a most important position as respects safety of life and property. He perhaps may do more than any other official to secure it by care, or endanger it by lack of vigilance. His relations to economy, too, are important. As the time of locomotives, cars, and employees, and of persons and things carried, is of value, delay avoided is money saved.

Train dispatching, it is said, was originated in 1851 by Charles Minot, general superintendent of the New York and Erie Railroad, when he issued from Turner's (now Harriman), New York, the first train order transmitted by telegraph. A tablet, erected by Mrs. E. H. Harriman, was unveiled at Harriman on May 2, 1912, to commemorate this highly important contribution to transportation practice. (Figure 27.)

It cannot be too strongly insisted that the man who issues train orders should make it his special business and should have no interference from others. The hours of duty and the question of other occupation must depend upon the frequency and constancy of the demands of the work specially in hand. Upon a busy road, where the trains are run much on orders, safety as well as efficiency will be best promoted by excluding other occupations and everything that may distract the attention.

The office where this work is done should be separate from others, and should not be subjected to the visits and conversation of outsiders or of employees whose business does not call them there. The dispatcher should be a proficient operator. He may not himself transmit orders, but must be able to read all that passes on the wire, in order to have an intelligent understanding of what is going on. He should be thoroughly acquainted with the location and length of the various sidings, the grades and curves, the capacity of the engines, and other matters which may affect the movements of the trains he has in hand, and some experience as conductor will be of value. He should be a man of

Fig. 27.—Tablet to Commemorate First Telegraphic Train Order.

more than average ability, of good judgment, clear head, and strictly temperate habits.

The train dispatcher may do much to assist the yardmaster by insuring the regularity of incoming trains; promptly moving trains out of the yard as they are reported ready; by moving fast or manifest freight trains into the yard in advance of a number of slow freights that may have become bunched; and by moving the trains so as to keep the terminal well supplied with power.

The train dispatcher's mind constantly is occupied in watching the movements of trains, noting the unoccupied room on each of the side-tracks, and considering the possibilities of the locomotives and men on different portions of the road under varying conditions of weather. Amid a continual clamor of detail he must be instantly ready to lay aside a subject that has been claiming the utmost concentration of mind, and to turn with the same careful consideration to another. If his trick is a busy one he should be supplemented with a good copying operator, and in all cases be surrounded with such protective measures as may be available.

108. Division Agent.—I had not been long a division superintendent when the agent at one of the important stations died. In considering his successor and the various transfers and promotions made necessary, I realized how little knowledge I had of the available men and that it was the particular business of no one to have this knowledge. This led to the development of the office of division agent, now a recognized position on many lines.

The division agent, under the direction of the division superintendent, has supervision over the station forces. He should see that they are kept down to a proper minimum consistent with business, that they are competent and efficient, and that loyal coöperation is maintained between them. From time to time he should make a careful check of station overtime with a view to the elimination of as much of it as can be avoided.

He should spend a considerable portion of his time in

visiting and inspecting stations, checking stationery and supplies to see that no unnecessary stocks are carried; should see that the office and freight house equipment is sufficient to meet the needs of the station and is kept in good repair; and should acquaint himself with the general conditions of all stations as to buildings, surroundings, etc., see that they are properly maintained and the work in connection therewith performed promptly and efficiently.

He should instruct the station agent in his duties, particularly with reference to the requirements of the various rules, regulations, circulars, tariffs, etc., and should see that the proper records are kept and required reports promptly rendered.

The division agent should also do everything possible to insure friendly relations between traders and the agent and station forces, as well as complete coöperation between the station and yard forces. He should keep in touch with shippers in an effort to secure heavier loading of cars, elimination of orders for cars not absolutely needed, especially duplication of orders at junction points, and the more prompt release of cars by consignees. He should see that only sufficient cars are ordered and furnished transfer and freight houses to meet their absolute needs, and that cars are loaded, unloaded, transferred, and handled promptly by the station forces, all with a view to eliminating, as far as possible, car detention, both by traders and by the railroad.

Briefly, the division agent's function, as a member of the superintendent's staff, is to relieve the superintendent of the detail of station supervision, keep him informed as to conditions, and do such other work as may from time to time be assigned to him by the superintendent.

109. Division Accountant.—The office of division accountant is an innovation in accounting organizations. Because of the fact that this position is not generally known, it is quite likely that his prerogatives, difficulties, and potentialities are not fully appreciated nor understood. One of the primary motives in creating this office was the desire to place a responsible accounting officer as near as possible

to the seat of divisional operations, in order that such operations might be correctly described and stated in the accounts.

Prior to the installation of the method now in vogue, the primary accounting was usually performed under the jurisdiction of chief clerks in the offices of the superintendent, master mechanic, division engineer, and others. The details gathered were reported to the central office, which was at times very far removed from the points where transactions were actually performed. It was found that this practice (instituted years ago when no extensive rail systems were in existence and when traffic was relatively light) not only placed unusual burden on technical operating men, but, furthermore, the facts were not correctly reflected in the final returns, officers and clerks in the central accounting office failing to portray the operations correctly through insufficient knowledge of transactions.

This officer, a division staff officer, may be considered as the "adjutant" of the auditor of disbursements. The selection, instruction, discipline, and development of his staff are left almost entirely to his own personal initiative. Among the many and varied accounting duties on the division under his supervision may be mentioned:

1. Proper keeping of time in all departments of the company.
2. Verification of reported time, and the preparation therefrom of pay rolls for the various employees of the railroad.
3. Recording of receipt and disposal of material, and actual verification thereof.
4. Verification of invoices.
5. Preparation and rendition of bills for collection, and verification of charges made against individuals and companies for services rendered by the company or benefits received therefrom (excepting, of course, transportation and services incident thereto, which are covered by published tariffs).
6. Issuance and enforcing of instructions governing the reporting of transactions.
7. Proper distribution of charges and credits for labor, material, etc.
8. Assembling and recording of all data necessary for the proper recording and reporting of operations.
9. Preparation of balance sheet, monthly, and other periodical reports, special reports and statistics, etc.

He should be prepared also, in addition to the above, to deliver to division officers an intimate explanation or interpretation of the operating results as indicated by the accounts. He also should make his own deductions from a survey of the records in his possession, and whenever it is found that the accounts reflect an unfavorable result or an uneconomical operation, it is his duty not only to report such a condition to the division officers, but also to give them the benefit of any plan or thought he may have by way of improvement.

The object sought is the absolute reliability and correctness of the statement of results. Division officers should appreciate that, through conferences or other means, the division accountant must be kept constantly informed of all transactions, some of which obviously would not ordinarily come to his attention, yet all of which he needs if he is to draw confident conclusions. Failure to report transactions or details of time-work or material affect the accuracy of the accounts and may be even more misleading than a deliberate misstatement.

110. Supervision.—I have already endeavored to set out my ideas concerning the organization, the duties of the several officers, and what is required of them. The supervision they exercise is for the purpose of giving effect to this authority to the end that the purpose for which the railway was brought into being may be accomplished.

When the merest beginnings have been passed it is organization alone which makes growth possible. The mass can only be energized and made to function when its parts are combined into a coördinated whole, so that the ideas of a responsible chief may be transmitted through all its parts, however numerous and distributed they may be, and his plans be given effect. The organization undertakes to lay down the duties and authority of each officer and man and their relative responsibilities thereunder.

The supervision is designed to secure the performance of the duties of the officers and men under its control. Only through supervision can organization be given vitality. We

must then take care to maintain both the integrity of the organization and a high standard of supervision.

The control of so large a body of men, so widely scattered and working under such a wide variety of conditions, can be maintained only by supervision and by discipline, not merely in the sense of master and disciple, where one sits at the feet of the other to receive instructions, but in that of discipline as a system of rewards and punishments, a condition controlling our relations with nature and indispensable in organization. For such is the constitution of man that there is always a small but dangerous minority against which men hold their property, their lives, their freedom, and their religion itself at the price of the jail, the penitentiary, and the gallows.

It were well if the officer spent sufficient time with the work under his control to acquaint himself fully with the circumstances under which it is conducted, the ability and disposition of the men and their mutual relations. Not only will this bring him in personal touch with them under conditions in which it is most valuable, but the men will have the personal acquaintance and the assurance that their work is understood by their superior officer.

While division superintendent I instituted the practice of having each train dispatcher ride a freight train over his district every other month, signing the train orders with the engineman and conductor. This gave the dispatchers opportunity to see just how the various trains did their work and the difficulties they had to contend with, to see the conditions at the several telegraph offices, and, riding some trips on the engine, some trips in the caboose, to see a great deal of the men with whom their official relations were so intimate. A like practice of other officers in their own fields may be followed to advantage. It is important that this association be known for just what it is,—avoiding anything that savors of surveillance or spying. When I went to a yard, whether by day or night, I went first of all to the office of the yardmaster and found some reason for being there ten or fifteen minutes, talking with him and looking

over his records, well knowing that by the end of that time every man in the neighborhood would know of my presence. I then took either the yardmaster or one of his people and went over the work I had in mind. Much may be accomplished in this way. I recall once going through a terminal yard at night to find the work badly delayed by the re-handling of a large number of no-bill cars. I first had a track designated on which they were put currently out of the way and then devoted myself to eliminating the causes of delay. Some of the cars were from connections and we arranged that the bills should come over with the cars; some of them were from our own stations and were delayed by the practice of not taking impressions of the waybills until all had been made out; this was corrected by taking impressions every hour of all bills made. As a result, the freight house office force got away earlier, the yard men could work with precision and confidence, the business was done more economically, and the cars dispatched earlier to their destinations. So far from resenting my inspection as an unwarranted intrusion, the echo I got was that they wished I would come oftener.

The men are very quick to appraise the true value of their officers. Men have scant respect for an officer who is incompetent, but an abiding confidence in the man that "knows how," who plays no favorites, who is quiet and unassuming, thoughtful and sympathetic. It is possible also to build up a very strong personal relation by some sympathetic interest in the home life and interests of the men. And no opportunity should be neglected to do so, because this is of great benefit to the men, the officer, and the company. Very great care should be exercised in the promotion of men, especially in the class of officers. A man may be incomparable as a lieutenant but possess none of the qualities of a captain. He may shine in the second rank only to be totally eclipsed in the first. And mistakes in this field are serious; in all kinds of climbing, as Catalani said of singing, it is far more easy to get up than to come down.

I am frequently asked what I think of the railroad as a

field for the employment of college graduates and perhaps cannot do better than to give here my reply to a recent inquiry:

> Acknowledging your letter of March 27, 1921, my own belief is that the complexities, as well as the scope, of the matters handled by the railway officers in the higher executive positions are now such that these positions are not likely often to be filled other than by men who have had such an orderly training of the mind as is secured through a college education, though there will happily always be those coming up in the service who, through correspondence schools, private reading, and by recourse to other agencies, will similarly fit themselves for the discharge of their duties.
>
> I have also felt that the railroad service offered a splendid opportunity to the virile type of man who enjoyed an outdoor life and intimate contact with his fellows, and that the service would be immensely benefited could a stream of men of this type, who had had football, baseball, or crew and other athletic training, be inducted. I have introduced a good many of these men into the service, and almost without disappointment. On the Delaware and Hudson we have taken most of our men from educational institutions contiguous to our own line, such as Rensselaer Polytechnic, Union, and Lehigh, and occasionally men from Rutgers (where I am a Trustee), whom I had personally met.

But if one is aspiring to the position of an officer he should recognize that neither physique nor education will suffice; he must beyond these have character and personality.

111. Methods in Administration.—The ancients looked to find in their leaders a sound mind in a sound body, and the dependence of success upon the possession of this necessary sound body is not sufficiently appreciated. Huxley claimed that no man could reasonably expect to lead in his profession unless he could, as occasion demanded, work sixteen hours a day for a week at a stretch, throwing into sharp relief the necessity of maintaining a reserve of energy.

We should subject ourselves to the same sort of painstaking periodical inspection that we give the locomotive. The teeth, the eyes, the arches of the feet, the internal organs should at intervals of two years, and oftener after the age of forty years, be gone over by competent specialists. Meanwhile care should be given the body and abuse of it avoided.

The teeth should be thoroughly brushed morning and night with a narrow brush, the eyes protected with glasses where these are needed to correct defective sight, proper exercises taken to prevent the arches of the feet falling down. The food should be thoroughly masticated and not swallowed until it has been reduced to the consistency of a thick soup. The gastric juice will digest chunks of meat in the stomach but the starchy foods must be thoroughly wet with the saliva in the mouth, and while some liquid should be sipped at each meal, none should be taken in the mouth while chewing the food. The ashes and sparks of the locomotive are an indication of the importance of the disposition of the waste products of the body, itself a heat machine which should be the subject of the same systematic and regular attention, and since the skin is perhaps the most extensive of the organs of elimination and of regulating body heat, great pains should be taken to keep it clean and its pores free.

When you go to bed, go there to sleep; do not lie in bed thinking or reading; and when you are called, turn out "all standing," as the sailor men say, and begin at once the routine of the day.

If you can train yourself to ten minutes of vigorous exercise in the setting-up movements of the army, or those recommended in the books on the subject such as "The Daily Dozen" by Walter Camp, they will keep the muscles supple and the blood in good circulation. William Muldoon, who is perhaps the best conditioner in the country, trains his patients to take their bath in one minute, divided as follows: ten seconds in which to wet the skin thoroughly, twenty seconds in which to soap thoroughly every part of the body, ten seconds in which to wash off the soap and water, twenty seconds in which to dry the skin. On retiring, the clothing should be neatly and systematically arranged and hung up, that it may be aired and dried out during the night, and so that dressing in the morning may not be delayed. Andrew Carnegie once told me that he took his morning bath and dressed in five minutes. He always was a fast worker, but

here at least is a mark to shoot at; if you cannot hit the bull's-eye, you ought at least to keep on the target.

It is well to keep at the head of your bed a pad and pencil. Frequently you may wake up with the solution clearly in mind of some problem you have been thinking of, or with some suggestion growing out of the activities of the preceding day which in the morning it may be impossible to recall. It should be noted down while available. The mind can only remember by free or by direct association. The working of the subconscious mind is a fact well known to psychologists but not yet well understood. That it may perform valuable service is, however, clear.

As a rule, those who have the habit of reading read too many books. It is far better to have a few and to live with them. I try to read only such books as I may own. As I read, I freely mark the margin of pages where the ideas the author is developing are most clearly stated. When I have finished the book, I turn back and read all the marked paragraphs and sometimes do this several times at short intervals. If the book is one I do not want to keep, I frequently remove the cover and separate the book in parts of a size convenient to carry in the pocket, throwing the parts away as read. We read far too slowly; with a moderate amount of definite practice and with a conscious effort to improve, the speed of reading may be increased from 50 to 100 per cent with gain in the comprehension of the ideas read.

During the past thirty years much attention has been given to reading processes. One of the latest works on the subject is *Silent Reading,* by John Anthony O'Brien, from which the following is largely taken.

In studying we repeat and recapitulate, and, as the mind is exercised in thinking and feeling, the rate is necessarily slow and naturally demands additional time. But, where the object is rather to gather thought from the printed page, to "get the gist," to get the central thought to answer certain specific questions, to secure a certain point of information, the ability to read with speed, and yet with understanding, is of fundamental importance.

All instruction in reading is in oral reading, and this method, involving an elaborate functioning of the physiological mechanism of vocalization, is relatively slow. And this training in oral reading, which lasts throughout all the grades of the elementary school, seldom, if ever, functions in after life. While for the silent type of reading, which one is obliged to use almost daily both in school as well as subsequently, the school makes no attempt to train. The distinction between the two types of work is fundamental and cannot be emphasized too strongly.

In oral reading the general mechanism of speech involves concomitant movements of the lips, tongue, inner palate, pharynx, and vocal chords, each word with its several syllables is separately pronounced, and so habituated do we become to an early training that many in silent reading may be seen to move the lips and repeat all the muscular efforts of the oral method with its slowing up of the rate of reading. The first effort then to improve speed is to eliminate this serious handicap, and practice in reading without articulation should be diligently pursued. The second great fault is that much of the time consumed in apparent reading, is, in reality, lost through unconscious wanderings of the attention and fruitless day-dreamings. How much of the time seemingly spent in the reading of a book is actually frittered away in listless lounging and idle woolgathering, especially if the subject matter is rather heavy and somewhat uninteresting, is difficult to determine; but that it is considerable the experience of most readers leaves no room for doubt.

Finally, there are three factors influencing the rate of silent reading. First, the speed with which the matter may be understood. The initial step is the breaking up of the slow plodding habits of reading best accomplished by practice in rapid, silent reading, until that type becomes habitual. The core is the process of perception, the actual seeing or visualization of the printed words. When the eyes are held quite stationary, only about five letters will be "unequivocally clear," and the plodder as he reads a line will make perhaps ten distinct pauses, while the rapid reader, with the

trained advantage of grasping what he sees somewhat indistinctly, will make but two or three. The effort then should be to so widen the span of attention as to grasp three, four, five, six or even more words, if possible, in a single fixation. It is then of the first importance to develop and widen the perceptual span, or at least to make more effective use of it.

Second, the eye does not move regularly along the printed line but jumps from one point to another, pausing at each point. These pauses vary from 8/50 to ½ second in time, and average roughly ¼ second.

Third, the eye, in moving along the line, does so with some uncertainty, and, with the slow reader, on an average stops twice to go back to make sure that the meaning of the passage has been grasped, and these "regressive movements" are even more time-consuming than the pauses.

Probably the chief reason why comparatively few readers have acquired the habit of rapid, silent reading is because of the general failure to recognize the possibility of greatly increasing one's rate and consciously to strive to secure the value of such a habit. Fordyce says that ten minutes' daily practice doubled his speed in reading in a single year. Having got rid of the handicap of vocalization, having acquired the habit of fixed attention, development of speed in silent reading is, in reality, reducible to the more effective utilization of the perceptual span in reading. This involves ability to acquire a regular and uniform or rhythmical motor habit of reaction for each line, and lessening the number of fixations rather than shortening the average duration of the fixation or an elimination of the regressions.

Not only is silent reading more rapid than oral reading, but rapid, silent reading is also superior in point of comprehension of the matter read, such readers often showing 40 per cent superiority over slow readers in quality of work. Earnest efforts should then be made to acquire a speed in silent reading of fifty pages per hour as a minimum.

In reading a newspaper it is well not to place too much reliance on the headlines. They are usually written by an-

other than the writer of the article and often bear little relation to its contents.

Since we owe all our progress to the work and example of certain great men, the careful reading of biographies will be both an inspiration and reassurance, and perhaps not directly, but yet by implication, answers will be found therein to many of the perplexities of life. Literary men generally unite in including among the great human documents of this character the *Autobiography of Benjamin Franklin.* Franklin was one of the very great Americans. You may well read his own study of his life.

While our native make-up determines to a large extent what we shall become, yet rarely does anyone utilize or develop to the fullest extent such measure of ability as he may possess. The laggard can find little consolation in the hope of redeeming himself later on. The chief source of waste in all mental work is the reluctance in beginning. This is best overcome by putting one's self into physical surroundings and into a frame of mind requiring at least a minimum amount of voluntary effort. Have a customary place to work, in surroundings with as few distractions as possible. It is very certain that there is an uncalculated waste of energy and a still more prodigal waste of time in most of our mental work. Vicious habits of dawdling are easily acquired, which, unless corrected, have their effect throughout life. Don't dawdle and think "I just hate to do this," but begin at once and in earnest. Organize your ideas, with reference to all the elements in the situation. As soon as possible put your ideas in permanent form, telling them to some one else in connection with other related materials or situations.

In handling your office work find out whether you succeed better by beginning in the morning with the hardest or the easiest task and determine your method accordingly. Personally, my rule is to take up first the thing I find hardest to do and work that off. Arrange that by the time you reach the office the mail clerk has all your mail on your desk sorted in accordance with your instructions. You will find

it of help if you make it your practice to dispose of a letter before laying it down. I allow no mail to be laid on my desk after I go out for lunch. If anything comes in later that the chief clerk thinks of sufficient importance, he brings it in and talks with me about it.

Too much time of the officers is devoted to handling correspondence—not that there should be any reduction in the number of letters written, or in the statements to be prepared; it may well be that an increase in these will produce better results. What I do suggest is that the work should be done by the clerical staff. It were better that the officer write no more than six or eight letters daily, and these should consist largely of letters initiated by him rather than of replies to letters received. The general run of letters, as well as of statements, should be handled by his aides. The officer should have his time free to study the matters which affect the economic operation of the property, to instruct properly those whose work he may directly supervise, and to transact business with those who deal with the company.

Keep constantly before you that the first thing to do is to look ahead; the second, to try to get good ideas; the third, to arrange your work in such a way that when you do anything you will not have to do it in a hurry.

The aim of every man should be so to discharge his duties or so to do something beyond them as to win the approval of his superiors. I recall Mr. McCrea discussing with J. T. Richards, with whom I had served, the disappointment and embarrassment caused him by the failure of one of his younger officers. Mr. Richards said to him, "You have got a good man in Loree. If you can't keep him busy send him back to me." I have always felt inspiration in the estimate Mr. Richards gave of me.

Almost the first work that I did in the railroad service was the overhauling and reindexing of the file in the engineer's office in which I was employed. In 1897–98 we put all the files of the engineers' and superintendents' offices of the Pennsylvania Lines on a uniform basis of indexing and established a "dead file," a duplicate of the "live file,"

to which was removed all correspondence covering subjects permanently disposed of. The results were so satisfactory that I endeavored to extend the system to the offices of the general officers, but found it incapable of expansion. I then arranged to have W. H. Williams examine the methods generally in use in business concerns and railroad offices both here and abroad, and to make a study of the Dewey Decimal System. The result of his studies is the index which he developed and published, which has proved effective where introduced, and is now in very general use. A good file is an indispensable condition of successful office administration.

You should make every reasonable sacrifice to accumulate a sufficient fortune to safeguard your future and insure personal independence and freedom of conduct. The man on a fixed salary is under a serious disadvantage, his income is known to all his family and the tendency is to live up to its last resource. For a number of years my wife and I struggled valiantly with this important problem and without any considerable success, when quite by accident we stumbled upon a method that was ease itself. I put in a savings bank account on the day I received my pay a fixed percentage of it and left it undisturbed to benefit by the rapid growth of compounding interest accretions. The balance I deposited in a national bank and this checking account was the only one we ever thought of as holding our disposable funds, and it seemed always quite ample for our wants. Later as my business experience broadened and as opportunities offered for investment, and the use not only of cash but of credit, these savings were available for that purpose. I made my first borrowing, when near forty, using my deposit books as collateral. I think I have never been out of debt since. In any large amounts, money must be earned with credits, and by this I do not at all mean to suggest speculation, though something may be said on both sides of legitimate speculative enterprises.

The future of the race is bound up in the use we make of our leisure; advancement depends on willingness to devote

four to six hours' time each day to self-training in addition to that occupied by the details of the day's duties. Roughly, twenty-two years are required to master the technic and detail and the sweep of a business enterprise. No one, aside from those possessed of genius or of unusual talent, may expect to win, in this field of endeavor, the goal of his heart's desire at an age much younger than forty-five.

One of the most common of mistakes made by the younger officer is, in hope of advancement or increased compensation, to move about from one service to another. Much of success depends upon association, and if one is fortunate enough to find himself in a group of the right sort of men he should be loath to sacrifice that very great initial advantage.

112. Intercompany Arrangements and Standard Practices.—The treatment of company organization would not be complete without a glance at the history and character of intercompany arrangements. Quite naturally the methods adopted by the stronger and more progressive companies were copied by their less energetic neighbors, and, where matters of mutual interest were involved, they were disposed of by arrangement between the companies immediately interested, whether two or more.

Perhaps the most pervasive of the practices of this character were the arrangements necessary in putting into effect time-tables. To avoid disposing of this matter by correspondence and by telegrams over a period of several weeks, informal meetings were arranged of railway officers connected with the operating departments for the purpose of arranging the details of through time-tables and connecting times, and these came to be known as time meetings, time-table conventions, etc. The earliest record of any meeting of this character available is that of a "meeting of general superintendents for the arrangement of a summer time schedule," held at the Southern Hotel, St. Louis, Mo., on May 14–15, 1872. Twenty-three lines were represented by 35 delegates. The only business transacted was the formation of a "summer time schedule," to take effect on June 2,

1872. The "Proceedings of Time Meeting," held at The Windsor, New York, on April 4, 1875, show that 24 roads were represented by 36 delegates. On motion of J. Tillinghast, general superintendent of the New York Central & Hudson River R. R. Co., W. F. Allen, editor of the *Travelers' Official Guide,* was elected permanent secretary of the convention. Mr. Allen was a son of Col. J. W. Allen, who was well known among railroad men of his day, and all of whose sons subsequently engaged in railroad work. W. F. Allen was educated at Episcopal Academy, Philadelphia, and in his earlier days was largely employed in railroad construction, carrying forward the work which his father had begun. It was principally through the ability, pleasant personality, and diplomatic capacity of Mr. Allen that this and the successor organization were developed and machinery brought into existence that has done much to stimulate the development of American railroad practice and standardize it in its best condition.

At the fall meeting the organization was given the permanent title of General Time Convention. While meetings were held in the spring and fall of each year, the business was limited to the arrangement of schedules and the fixing of the time on which they were to take effect, until, on October 13, 1881, the question of the adoption of a uniform system of standard time to govern the running of trains was brought before the Convention and referred to the secretary with instructions to report upon the same.

At the same time the question of the continuance of the meetings of the Convention arose, and the following year it was submitted to the members by circular. The opinion was practically unanimous that it was very desirable that the organization should be maintained. It was felt that nearly every road had some change of time to make and that these meetings afforded the best machinery to reach an understanding regarding such changes; that the conventions were a source of much pleasure and instruction; that valuable acquaintances were formed and opportunities offered for officers to compare notes and exchange views and experi-

ences; and that harmonious and closer personal feelings were promoted.

The adoption of a standard time on October 11, 1883, was followed later by the adoption of uniform train signals, and these by uniform telegraph orders and general rules.

Through the activities of Mr. Allen an organization called the Southern Railway Time Convention met on October 29, 1877, at Barnum's Hotel, Baltimore, Md., Mr. Allen being elected secretary. Its business was limited to arranging for schedules and fixing the dates on which they were to take effect.

The existence of two organizations developed certain disadvantages, the additional work taken on by the General Time Convention having to be acted upon separately by the Southern Railway Time Convention and only after it had been completed by the former organization. The General Time Convention of October 8, 1885, after giving consideration to the situation, passed the following resolutions:

Whereas, The original object for which this Convention was organized was to arrange for the moving of through trains between Eastern and Western points, and the determination of the date for making general changes in time schedules; and

Whereas, During the past three years other subjects of interest to all railway lines in this country, such as Standard Time, Uniform Signals, Uniform Train Rules, etc., have been discussed at the meetings of the Convention, and advantageously acted upon; therefore,

Resolved, That in addition to the subject of through trains and general changes of time, the General Time Convention take up, discuss and formulate recommendations upon such general subjects of mutual interest to the operating departments of our railway lines as may be brought before it.

Resolved, That a copy of these resolutions be forwarded to the managing officers of the operating departments of all roads in the United States and Canada, with an invitation to participate in the proceedings of the Convention.

Resolved, That the Secretary be directed to transmit a copy of the Proceedings of this Convention to the Southern Railway Time Convention, with a request that they give general consideration to these resolutions, and invite their coöperation.

Committees were appointed by both organizations, who reported that they believed great advantages might be de-

rived from an organization composed of the members of the two organizations and they therefore favored their consolidation. Accordingly, on April 14, 1886, both conventions met at the Grand Hotel, Cincinnati, and, after being formally convened, adjourned, *sine die*, to meet in joint session. Whereupon, the meeting being called to order at 11.30 A.M., and the committee on permanent organization having presented rules of order and the committee on nominations having submitted its report, a recess was taken until 2.00 P.M., when the convention reassembled and the representatives of 54 companies signed an agreement pledging their respective companies to membership in the Convention.

The objects of the organization as set out in its rules of order were to "decide upon the dates on which general changes in time shall take effect, and other matters of mutual interest in reference to time-tables; to facilitate the interchange of views and the compilation of information respecting the most efficient methods by which railway lines are, or may be, operated, and to formulate recommendations respecting uniform rules for conducting the same. Its action shall be recommendatory in its character and shall not be binding on any of the companies represented therein."

The Convention was fortunate in the election on April 14, 1887, of Col. H. S. Haines as president, who continued in office until April 15, 1896. His executive ability, command of parliamentary practice, knowledge of the business, and broad views added much to the success of the organization.

This organization continued under the designation of The General Time Convention, but, confused impressions having arisen as to its relations to the several departments of railroad operation, its name was changed to the American Railway Association on October 14, 1891. Very much of the history of the appliances used and practices followed at the present time is to be found in its records, which may be studied with profit by those desiring to know their history and to understand the principles and reasons which they embody. They deserve the serious study of the younger officers. The more important of these are the following:

	Date of action
Uniform standard time	Oct. 11, 1883
Uniform train signals	Oct. 9, 1884
Standard clocks and examination of watches	Oct. 13, 1886
Continuous movement of freight trains	April 11, 1887
Uniform telegraph orders and general rules for governing train service	Oct. 12, 1887
Car Service Interchange Rules	Oct. 12, 1892
General regulation of employees	April 7, 1897
Interlocking and block signal systems	Oct. 6, 1897
Detouring trains	April 24, 1901
Examination of employees	April 5, 1905
Safe transportation of explosives	April 25, 1906
Standard Cipher Code	Oct. 24, 1906
Standard Code of Air Brakes and Train Air Signal Rules	April 22, 1908

Modifications in the structure of the American Railway Association were made from time to time, and on April 22, 1908, a report made by Daniel Willard, G. L. Potter, and myself was adopted, bringing into official relation with the American Railway Association voluntary associations having to do with special features of operation and maintenance, and rearranging the administration of the American Railway Association. The report, as adopted with some modifications, distributed the work of the Association as follows:

To conduct the work of the Association as an organization:
1. Executive Committee.
2. Nominating Committee.

To have charge of the investigation of certain features of railroad operation:
3. Committee on Transportation.
4. Committee on Maintenance.
5. Committee on Relations between Railroads.
6. Committee on Electrical Working.
7. Committee on Safe Transportation of Explosives and Other Dangerous Articles.

Extensive use was made of the Association by the Director General during the period of Federal control, and upon the return of the roads to their owners the following organization was put into effect, thus giving the Association

control of all the operating activities affecting relations between the roads:

To conduct the work of the Association as an organization:

1. Board of Directors
2. Executive Committee
3. Nominating Committee

To have charge of the investigation of certain features of railroad operation:

Division I. Operating
Division II. Transportation
Division III. Traffic
Division IV. Engineering
Division V. Mechanical
Division VI. Purchases and Stores
Division VII. Freight Claims

To these have since been added:

Car Service Division
Joint Committee on Automatic Train Control
Joint Committee on Fuel Conservation.

On August 1, 1910, the roads organized, with headquarters at Washington, D. C., the Bureau of Railway Economics for the purpose of gathering statistical information and pursuing statistical inquiries into operations both here and abroad, as well as collecting a library of railroad literature. The bureau now has approximately 110,000 books and pamphlets, probably the most complete collection of its kind in existence, and has been particularly useful in gathering information for the support of the tariffs urged by the railroads before the Interstate Commerce Commission and data dealing with wages and conditions of employment in questions submitted to arbitration committees.

About December, 1909, there was formed an Advisory Committee for the purpose of harmonizing the attitude and presenting the views of the railroad companies as to federal legislation affecting railroad interests. On December 12, 1913, its name was changed to the Supervising Board; in February, 1914, the name was again changed to Railway Executives' Advisory Committee on Federal Relations, and

on December 4, 1918, the organization was finally designated as the Association of Railway Executives. At the present time this Association exercises a supervisory control over the American Railway Association, Railway Accounting Officers' Association, Railway Treasury Officers' Association, the Bureau of Railway Economics, and the Presidents' Conference Committee on Federal Valuation of Railroads in the United States.

113. Extracorporate Relations.—The conduct of the business has been very materially aided through work of a very high class done by agencies quite outside the organizations of the railroads, but totally intimate with their various activities. I am very much indebted to J. E. Fairbanks, general secretary of the American Railway Association, for aid regarding them. They are, of course, the familiar tools of those in higher executive positions and have served as guide, philosopher, and friend to the ambitious aspirant. Without exception they have had a serious purpose to develop, by investigation and publicity, the science and art of railroad transportation, improvement of appliances, methods of operation, fair and convincing studies of the basis of rates, causes of accidents, instruments and methods making for safety and economy, and the traffic department's undertakings to develop the country—all those wonderful works by which railroad men make the region they serve rich in order to create transportation for their lines. They have, from week to week, given the railroad officer a knowledge of others' appliances and methods and kept him in touch with the service throughout the country. Promotion will be a force to be reckoned with as long as people are human. Safety depends upon its being stimulated by correct presentation of facts, and these publications have furnished a forum for such presentation. The relation of the community to the railroad cannot safely be neglected to the point where public sentiment makes itself felt in adverse legislation, and in this field their service has been great, both to the railroads and to the lawmakers.

114. *The Official Railway Guide.*—The railroad publica-

tion most familiar to the public is the time-table. A passenger, undertaking a journey of any considerable length, may use several roads, frequently those at a distance, time-tables of which are not easily procured. It is convenient, also, to have under one cover the time-tables of all roads which one may have occasion to use. These necessities give rise to the publication of "railroad guides" of which "Bradshaw" is the prototype. Several guides were started in the early days of American railroads by private publishers: *Disturnell's Railroad, Steamboat & Telegraph Book,* New York, 1850; *Cobb's American Railway Guide,* New York, 1851; *Dinsmore's American Railroad and Steam Navigation Guide and Companion,* New York, 1856; *The Pathfinder,* Boston, 1849, which is still published; the *Rand McNally Railway Guide* in Chicago, and others. That with the most general circulation was *Appleton's Railway & Steam Navigation Guide,* New York, established in 1856, which survived under another publisher until May, 1919.

The necessity for a medium in which railroad officers would find accurate time-tables of all roads, information about connections and through cars, the names of the officers of each road in charge of operation, and traffic and interline financial settlements, led to the establishment in 1868 of the *Traveler's Official Railway Guide,* which was constituted by resolution of the National General Passenger and Ticket Agents' Association the recognized organ of that Association. While privately owned, this guide has been developed by coöperation with the railroad officers to meet the requirements of traffic as they grew, until it is now, in its fifty-fourth year, a book of over 1500 pages, weighs about three-and-a-half pounds, and is the largest monthly publication in the world. The dimensions of the *Official Guide* have kept pace with the growth of the American railroad system. It began with 150 pages, $6\frac{1}{2} \times 4\frac{3}{4}$ inches, the same as "Bradshaw"; soon enlarged to the present size, 10×7. By 1878 there were 348 pages; in 1888, 736 pages; in 1898, 1042 pages; in 1908, 1424 pages; 1918, 1536 pages; in June, 1921, 1512 pages.

The *Official Railway Guide* is revised and published

monthly. It contains maps of the principal roads and systems, time-tables, through sleeping and parlor car schedules, sailing schedules of the principal steamer lines, and lists of the officers of all railroads in the United States, Canada, and Mexico. The index of stations contains the names of over 100,000 points to which freight may be shipped or passengers ticketed, and it is significant of the shifting that is constantly taking place in operation and service of the American roads, that it is necessary to make over 2000 changes every month in this index.

A supplement gives the list of officers of railroad associations, instructions for interline settlements of passenger accounts, a list of old and new names of roads, and another gives the name of every coupon ticket agent in the country.

115. *The Official Railway Equipment Register.*—As railway operations have broadened in scope and the average haul has lengthened, problems of intercompany and even of intersystem operation and settlement have multiplied. Many of these operations and settlements, which were simple of applications where the several divisions of one system were alone concerned, or even when immediately connecting systems joined by mutual agreement in their settlement, became exceedingly complex when it became necessary to extend similar operations or settlements universally as to the North American Continent.

In the days when each operating company, large or small, confined the use of its cars to its own rails, the questions of car hire, or return of car to the owner, were unknown, and the matter of demurrage was so distinctly a local matter as to be susceptible of application by orders adjusted to the car supply conditions of each locality.

In the present stage of transportation development it is difficult to realize that a practice prevailed within the recollection of some who are still in active service; namely, the use of a freight car only to the terminus of the road owning it. At that point the freight was transferred into the car of the connecting line and so on until delivered at destination in the car of the road last handling the freight.

As it became necessary to allow cars to move to connecting lines, difficulties incident to the possession of cars of varied ownership multiplied. The car record office of each railroad maintained a scrap-book file consisting of the equipment lists of such railroads as published them in official form and distributed them to other roads. This method having become too cumbersome, in 1885 there was adopted by the Car Accountants' Association, *Sechrist's Handbook,* a private enterprise undertaken for the purpose of bringing within one cover the published equipment lists of all car owners. This name was later changed to the *Official Railway Equipment Guide,* and in December, 1896, to the present name, *The Official Railway Equipment Register.*

Each car owner inserts in the *Register* columns the following detailed information:

Kind of cars
Numbers
Dimensions of cars (inside and outside)
Door measurements
Capacity (cubic feet and pounds)

Each car owner also inserts in the *Register* detailed information showing:

Officer in charge of maintenance of rolling stock
Officer to whom bills for car repairs should be rendered
Officer in charge of car distribution and embargoes
Officer in charge of car records
Officer sending and receiving mileage or per diem reports
Officer in charge of inter-line freight accounts
Officer with whom per diem settlements should be made
Data as to number of cars of each class, separated as to axle or marked capacity

In the routing of car equipment, the freight interchange junction point is an important factor; therefore each system shows these points arranged alphabetically as to connecting roads and as to names of towns. Many of the important roads have also authorized the insertion of freight interchange

maps, which are designed by the *Register*, to give prominence, from a freight traffic standpoint, to the interchange points.

In January, 1912, the Interstate Commerce Commission issued an order establishing a car capacities and dimensions tariff. This order but served to confirm, in legal tariff form, that which the roads, through their various organizations, had already undertaken in a voluntary way.

Information in condensed form relating to railway clearances was included in early editions of the *Register*. With the growth in railway mileage during the decades of 1880's and 1890's, it became necessary, in order to meet the requirements of the service, to issue these data in separate pamphlet form.

A pamphlet of twenty-six pages was issued in January, 1897. As a very general distribution by the larger roads was made of this pamphlet, the compilers supposed that an occasional issue as an extract from the *Register* would meet all requirements. However, such was not the case, for within four months such a considerable number of roads had signified their desire for a reissue of the pamphlet that the publication in permanent separate form of a quarterly edition under the title of *Railway Line Clearances and Car Dimensions* was determined upon. Issue No. 1, in this form, was dated July, 1897.

The publication as originally designed carried, whenever furnished for publication, either local or through system clearances or both. From time to time change in form of setting forth the detailed clearance data was suggested. As early as 1907, certain roads adopted a graphic form of displaying these data.

In the form in which the clearance data are now published, the data are intelligible to both the technical and the non-technical mind. If desired a cross section sketch can quickly be prepared from these figures from any regular freight route on the North American Continent. The arrangement of the data is such that in each column the reader starts from the rail, as zero, and reads upward (in figures, feet and inches) the permissible measurement (width

of vehicle) at each intersecting 3-inch interval in height from the top of rail until the level of the car body is reached (approximately 4 feet from top of rail). From that point to a point representing in general the height of an ordinary enclosed car the figures are given at 6-inch intervals. From 13 feet in height from top of rail the permissible measurement (width of vehicle or load) is given at each intersecting 3-inch interval in height from top of rail ending at extreme height, but in no instance exceeding 22 feet from top of rail.

When the Bureau of Explosives adopted the regulations for the safe transportation of explosives, inflammables, and other dangerous articles, the regulations were published regularly in this publication. This practice prevailed until about the time that the Interstate Commerce Commission requested that the regulations be given effect of a tariff filing. In the meantime, the Bureau of Explosives began the issuance of a series of bulletins for general distribution to both shippers and railway officers and employees to warn all concerned as to the dangers of improper loading and handling, and conveying instructions and suggestions for avoiding the same; also a bulletin of "Restrictions." These bulletins have, from their start, been published regularly in *Railway Line Clearances.*

116. *Poor's Manual of Railroads.—Poor's Manual of Railroads* for 1920 is the direct, lineal successor to the *American Railroad Journal,* first issued January 2, 1831, in New York City by D. Kimball Minor, "publisher and part proprietor." The journal was continuously published weekly by Mr. Minor until February 3, 1849. It then contained sixteen pages set in three columns and the price was $5 a year in advance.

In February, 1849, John H. Schultz & Company became proprietors of the *Journal* under charge of Henry V. Poor, who continued as sole editor to July 28, 1861. On August 3, 1861, John H. Schultz became joint editor with Mr. Poor and continued in that capacity up to August 23, 1862.

In September, 1860, after eleven years as editor of the *American Railroad Journal,* Mr. Poor announced the publication of the first volume of the *History of the Railroads and*

Canals of the United States. The volume of 625 pages embraces regular statements of the railroads of the eastern states.

The official reports collected by the *American Railroad Journal* since its foundation in 1831 formed the basis of the *History of the Railroads and Canals* edited by Mr. Poor and published in 1860.

In announcing the issue of this work, the editor stated:

> This work, which is the first of its description ever issued, and which traces the history of American Railroads and Canals through their varying fortunes from the earliest period to the present day, has been written under peculiarly favorable circumstances, whether in relation to editorial experience, or the possession of the material necessary for the proper illustration of the subject. It is based principally on official reports published from year to year, *and which for the past thirty years have been accumulating in the office of the American Railroad Journal.*

In 1861 Mr. Poor announced that he had in preparation the second and third volumes of his *History of the Railroads and Canals of the United States,* one embracing the western and the other the southern states. These two volumes were never issued, as the outbreak of the Civil War upset all prearranged plans for their issue. The material prepared by Mr. Poor, however, was preserved, amplified, brought up to date, and, together with the information contained in the published first volume, formed the groundwork for the first number of *Poor's Manual of Railroads,* which was issued in 1868.

The First Annual Number of *Poor's Manual,* and the first of the series of which the 1920 number is the Fifty-third Annual Number, published in 1868, comprised 442 pages of text devoted to the regular statements of the railroad companies of the country. For all the larger companies statements are given covering their financial operations for a period of years from 1861, so that the continuity of the data given in the *History of the Railroads and Canals of the United States* (first volume) is thus preserved.

In 1879 there was begun publication of statistics of street railways or tramways, as they were then called, in the *Rail-*

road Manual. At first the returns of the states of New York, Massachusetts, and Pennsylvania were presented, but by the year 1886, the statements of street railways shown in the *Manual of Railroads* for that year had been extended to cover the entire United States, the first information given to the public in this form.

In the *Manual* for 1883, there were published a few statements of "miscellaneous corporations" affiliated with the railroad interest, but it was not until 1886, that this section was enlarged to cover certain industrial companies in which there was then enough public interest to warrant their publication in the *Manual.* This department was elaborated yearly until it was deemed advisable to publish the statements of "industrials" in a separate volume.

Consequently, in the year 1890, there was issued the first annual number of *Poor's Handbook of Investment Securities.* The second and third volumes were published in 1891 and 1892. The last number comprised 986 pages of text, and, in addition to the statements of "industrial and miscellaneous corporations," contained the debt statements of the United States, of the several states, and of the chief cities, towns, and counties in each state. It also contained the first published record of dividends by the leading railroad companies of the country since their organization; bank statements; range of stock and bond prices from January 1, 1886, to October 31, 1892, of the more active stocks and bonds on the lists of the New York, Boston, Philadelphia, and Baltimore stock exchanges; together with information as to annual meetings, etc. The publication of this work was not continued after 1892, but its chief features were incorporated in the *Manual of Railroads* in the succeeding year.

In 1886 the first number of *Poor's Directory of Railway Officials and Manual of American Street Railways* was published by H. V. and H. W. Poor, and was issued annually until September, 1896. The publication of the work was suspended in 1896, but its chief features were incorporated in the next issue of the *Manual of Railroads.*

In 1887 the Interstate Commerce Commission Bill was

passed (effective April 5th of that year) which provided, among other things, that all the steam railroad companies of the country should file annual reports with the Commission covering their operations. It was, however, some years later before the machinery of the Commission was in working order, making returns to the Commission available for public use. So that, from 1860 to about 1890, the *Manual of Railroads* was the only publication from which the annual reports of the railroad companies could be obtained. It was during this period that the *Manual*, indispensable to the financial community, became known as the "Railroad Man's Bible." Wherever railroad affairs were discussed or information sought respecting the operations or finances of the companies, it was consulted.

In the year 1900 *A Study in Railway Statistics*, being a review of the development, finances, etc., of the railroads of the United States, with special reference to the period from 1880 to 1899 was published in pamphlet form by H. V. and H. W. Poor. This work was in preparation for a number of years and represented a great deal of laborious research. It was reprinted in the introduction to the *Manual of Railroads* for 1900, thus preserving for all time its invaluable collection of early railroad statistics of the United States specially prepared by H. V. Poor.

Poor's Manual of Industrials and *Poor's Manual of Public Utilities* were published in 1910. They were issued annually until 1918 inclusive, when the consolidation of Poor's Manual Company with the Moody Manual Company no longer necessitated its publication.

The first volume of *Poor's Handbook of Investment Holdings* was published in 1908 and the tenth and final volume in 1918 (copyrighted 1917). Similar data are now published in *Poor's Classified Investment Holdings.*

The first number of *Moody's Manual* covering industrial and miscellaneous corporations was issued in 1900. This work was issued up to and including 1913, and was enlarged to contain, in addition to industrial and public utility companies, statements of the larger railroad companies.

In 1914 *Moody's Manual* was issued in two volumes, one volume concerning railroads, and the other industrial and public utility companies. The railroad volume was published annually until 1918, inclusive, when the consolidation of the Moody Manual Company with Poor's Manual Company rendered further publication of the railroad volume unnecessary.

In 1917 the public utility section of *Moody's Manual* was issued as a separate volume, and has been issued yearly since. In the 1919 issue were incorporated whatever data that had been previously published exclusively in *Poor's Manual of Public Utilities.*

In 1917 the industrial section of *Moody's Manual* was issued as a separate volume, and has been issued yearly since. In the 1919 issue was incorporated any information of value that had previously been published exclusively in *Poor's Manual of Industrials.*

In November, 1918, a consolidation of Poor's Manual Company and Moody Manual Company was effected under the name of Poor's Publishing Company. The result of this consolidation is reflected in the enhanced value of the consolidated manual which embraces in its three volumes all the best features of the several works previously published by the constituent companies.

As may be seen from the foregoing, *Poor's Manual,* as it exists to-day, represents the accumulated results of ninety years of railroads (1830), forty-one years of public utilities (1879), and thirty-four years of industrials (1886). It is the only financial publication extant that has such a record in its line.

117. *Commercial and Financial Chronicle.*—A weekly financial paper containing much information relative to railroads, the first number of which was issued in July, 1865. It has been continuously published since. It succeeded the weekly publication, *Hunt's Merchants Magazine,* also a weekly paper devoted to finance, and which was founded in the late thirties.

118. *Railway Age.*—On January 2, 1832, the first railway paper in the world and America's first technical paper was

published in New York City. It was named *American Railroad Journal.* The publisher said that "the principal object in offering the proposed work to the public is to diffuse more general knowledge of this important mode of internal communication which at this time appears to engage the attention of every section of our country."

At its inception, the *American Railroad Journal* was a weekly, but in later years it was published once a month only.

The next American railway paper of importance was the *Railroad Gazette,* Chicago, 1856. Published weekly, it resembled the daily newspaper of to-day except that it was much longer and wider and consisted of four pages only.

In 1876 another weekly paper appeared in Chicago, *The Railway Age.* In the meantime the *Railroad Gazette* had been driven to New York by the great fire of October, 1871.

Between 1832 and 1876 other railway papers came and went, here and there one surviving, but it is to these two papers that the railways of this country owe much for sane advice and constructive help.

In the early seventies some railways were laying rails 5 feet apart, while others were putting them down 3 feet or 3 feet 6 inches apart. The *Railroad Gazette,* with clear vision of future possibilities for interchange of traffic, fought the situation and finally brought about the adoption of the prevailing standard gauge of 4 feet 8½ inches.

The next important fight for progress in which the *Railroad Gazette* engaged was for the adoption of air for braking trains, following a visit to its office of the late George Westinghouse with a model of his apparatus under his arm. Again it was vision which prompted the editor to urge its trial and later its extended use; but so vigorous was his urging that for many years it was frequently said that the paper was owned by the Westinghouse Air Brake Company. As a matter of fact, at no time in the history of the *Railroad Gazette* did anyone other than those actually connected with the paper own a share of its stock.

Another piece of constructive work started by the *Railroad Gazette* resulted in the adoption of standard threads for bolts

and nuts. Mathias W. Forney, the editor of the paper, who began the campaign, used to say that the *Railroad Gazette* published on the subject "as much as would make a book as big as the New Testament, or larger."

By a judicial arrangement of the facts, the *Railroad Gazette* settled the considerable controversy over rivets *v.* pin-connected bridges. Later it had much to do with the adoption of a standard type of car coupler.

In 1904 the publisher of the *Railroad Gazette,* believing that through an American-owned paper published in England, much could be done to extend American railway practices abroad and thus to further the sale of American-made railway equipment and supplies, bought *Transport,* of London, an old weekly paper devoted to transportation on both land and water. Under the name *Railway Gazette* a policy of very gradual Americanization was started, but after a few years' trial the policy was given up as unsound and the paper was sold to those on the other side who had been responsible for its conduct during the experimental period.

In 1908 the owners of the *Railroad Gazette* bought *The Railway Age* and the two were consolidated under the name *Railroad Age Gazette*—later changed to *Railway Age Gazette,* and then to its present name, *Railway Age.*

In 1917 it was seen that Government operation of our railways as a war measure was contemplated by the administration. From that moment the whole force of the paper was trained against the possible added calamity of government ownership; and not until the railways were actually turned back again to their owners to be operated was there any let-up. The publisher does not claim that the *Railway Age* fought the battle alone; but he does claim that it was the greatest single factor in bringing order out of chaos and in preventing government ownership.

In May, 1910, the *Railway Age* bought the *Signal Engineer,* a monthly published in Chicago, devoted exclusively to the subject of railway signals, printing and mailing it in Chicago as the *Railway Signal Engineer.*

In November, 1911, the *Railway Age* purchased the

monthly *American Engineer and Railroad Journal,* formerly the old *American Railroad Journal* with which had been combined the *National Car and Locomotive Builder,* publishing it as the *Railway Mechanical Engineer.*

With the growth of the use of electricity in steam railway service, the *Railway Age* kept its readers fully posted through its own columns until October, 1915, when it bought the *Electrical Engineer,* a monthly paper published in Chicago, moved it to New York, naming it *Railway Electrical Engineer.*

In April, 1916, the *Railway Age* bought *Railway Engineering and Maintenance of Way,* an old Chicago monthly which had been moved to New York, renamed it *Railway Maintenance Engineer,* and transferred it back to Chicago, where it is still published. At the same time it bought also from the publisher of the last named paper the *Railway Master Mechanic,* a former Chicago monthly, and merged it into the *Railway Mechanical Engineer.*

As to the *Railway Age* during the transition period, it, too, by degrees, occupied a clearly defined field. Instead of printing detailed drawings and descriptions of signals, locomotives, cars, and bridges, such as appeal more especially to signal engineers and mechanical, electrical, and civil engineers, it now discusses those subjects mainly from the operating point of view. Instead of a minute illustrated description of a new superheater or valve gear, just enough is printed to inform executives generally about how it is made, how it works, and the part of the engine to which it is applied, the rest of the article being devoted to the reasons for its use with data having to do with that phase. Also, it deals with railway finance, stores, traffic, and last, but not least, public relations matters which concern our railways. It is probably true that no other technical journal in the world is quoted as frequently and fully by the daily newspapers as is the *Railway Age*—a great tribute to its strength and a considerable factor in molding public opinion.

119. *Railway Review.*—The *Railway Review,* a weekly journal devoted to all phases of what is popularly called

"railroading," first appeared in June, 1868, under the auspices of two daily newspaper men. Its career was well-nigh ended by the great Chicago fire. In those days railway news was plenteous and of absorbing interest, the chronicle of new construction, the developing of new territory, and the description of natural resources called for a journal which should be both enterprising and reliable. Only two sets of the *Railway Review* of those earlier days are known to exist, one in the publishers' hands, the other in the library of the Chicago Historical Society. Shortly after the great fire, Willard A. Smith, who for several years had published a weekly paper known as the St. Louis *Railway Register*, becoming convinced that Chicago was to be the great railway center of the country, purchased the *Railway Review*. For forty-eight years he has edited and published the paper, which has never missed an issue; and it has remained continuously under the same ownership and direction.

In the earlier days of the *Railway Review*, the Granger movement began and gave rise to new lines of thought, attack, and defense. The relations of the railways and the public have continued to offer a problem of ever-increasing importance.

At the St. Louis World's Fair in 1904 there was shown the first American Mallet Compound, the largest locomotive built up to that time. A photograph was printed of it with an exact reproduction of Stephenson's "Rocket" standing alongside, on the track of its period. It was a lively reminder of Landseer's famous picture "Dignity and Impudence."

The *Railway Review* became gradually a technical journal and at the same time participated in all the progress of the tide of railway development. Through the connection of its chief editor as chief of transportation in the great expositions at Chicago, Paris, 1900, and St. Louis, it was brought into international importance. It carried through a dream of years in the great laboratory for testing locomotives at the St. Louis Exposition. Its influence for fifty years has been that of a practical university extension in railway construction, maintenance, operation, and management. Many years

ago it secured a series of articles from the leading railway officials of that time, a day when men of that class rarely wrote for publication or made speeches. Among these articles was one by Judge Cooley, the great constitutional lawyer, which was his first utterance on the railway problem, and influenced his election as first chairman of the Interstate Commerce Commission which he so wisely organized. It has always been an independent institution, promulgating its own editorial views, and at all times abreast of the best thought and work. It has never received subsidy or subvention, has never been subserved or been an organ of any railway or railway companies. It has grown coincidentally with the great interests to which it has been devoted. At all times the *Review* has been sympathetically critical both of government regulation and of railway management. For some years its editorial legend has been: "To think clearly, to speak plainly and to say the thing that ought to be said." It is not dogmatic nor does it claim any degree of infallibility, but time has justified its policy in the past as it hopes it will in the future. It renders to its readers a unique and valuable service.

A careful computation shows that the reading matter published in the *Railway Review* to the present time would make a library of over 2400 large books. Practically all of this was contemporaneous history. The complete volumes, therefore, constitute a source book for the study of the history of railways for over a half century.

120. *Engineering News-Record.*—The first number of *Engineering News* appeared on April 13, 1874. It was founded by George H. Frost, a graduate of McGill University at Montreal, who, in the early seventies, was a Chicago land surveyor.

Mr. Frost conceived the idea of publishing a journal for civil engineers during the hard times of 1873 when the surveying business was extremely dull. The paper first appeared under the title *Engineer and Surveyor.* The second and succeeding issues of the journal, until 1875, appeared under the name *Engineer, Architect and Surveyor,* a monthly

journal of sixteen pages. In the beginning of 1875 the name was changed to *Engineering News*.

At the beginning of 1876 the journal changed from a monthly to a weekly. The size of the page was increased to that which was thereafter followed for thirty-five years; each number contained eight pages.

On December 1, 1878, the publication offices were removed to New York.

At the beginning of 1883 Mr. Frost solved the long-perplexing problem of editorial management by selling one-third of his interest to D. McN. Stauffer who had nearly twenty years' active experience in civil engineering work.

In January, 1887, Arthur Mellen Wellington, who had made a high reputation by his treatise on the *Economic Location of Railways*, and who had two years' experience as an associate editor of the *Railroad Gazette*, purchased a one-third interest in the *Engineering News* and was installed in editorial charge. The various schemes that Mr. Wellington's fertile brain evolved for the development of the journal made necessary almost at once an expansion of the staff engaging conspicuously Charles Whiting Baker, F. P. Burt, and M. N. Baker.

Mr. Wellington had overtaxed himself in the preparation of his treatise on railway location, and in the early nineties his health failed, his death occurring in 1895. In the years previous, during Mr. Wellington's long absences and extended illness, Charles Whiting Baker had been in charge of the paper and on Mr. Wellington's death succeeded him as editor.

In August, 1911, Mr. Frost sold the journal to the Hill Publishing Company.

121. *Railway and Locomotive Engineering.—Railway and Locomotive Engineering* is a monthly publication issued for, and in the interest of, the mechanical departments of the railways. It deals with the design, construction, maintenance, machinery, and shop operations in connection with repair of rolling stock and the appliances used on such equipment. It is now in its thirty-fourth year of continuous publication and is a recognized authority in the special field that it rep-

resents. Sinclair especially made it the vehicle for the expression of his powerful personality, the repository of his wide experience.

In January, 1887, the American Machinist Publishing Company, New York, published the first number of the *Locomotive Engineer,* as it was then called. The size of the paper was 9 × 12 inches and twelve pages of reading matter were given each month, the price being $1 a year.

The subjects discussed embraced everything relating to the motive power and operation of railroads in short, succinct articles seldom exceeding 1000 words in length. Correspondents readily volunteered to ventilate their opinions, and discussions of practical subjects soon became a valuable feature of the paper.

In October, 1891, Angus Sinclair joined Mr. Hill in purchasing the paper; the name was changed to *Locomotive Engineering,* indicating wider scope, and it was doubled in size.

The first issue prepared by the combined partners appeared in January, 1892. The improved and expanded form of the paper made a wonderfully good impression and the publishers were literally flooded with letters of congratulations from all classes of railroad men. The success of the enterprise was assured, and nothing more was necessary than to keep the paper up to the initial standard.

In June, 1897, Mr. Angus Sinclair became sole proprietor of the paper.

In January, 1901, the name of the paper was changed to *Railway and Locomotive Engineering,* the addition indicating more clearly its developed scope.

Under Mr. Sinclair's direction the publication continued to grow in popularity and influence. He had surrounded himself with most able assistants, a great many of whom have risen to distinction in the field of engineering journalism.

On the death of Mr. Sinclair in 1918, the control of the publication passed to the management that has been conducting the business for the past fifteen years. It is noteworthy that in the history of this publication there have been

few changes in its ownership or management. There have been no consolidations with other journals.

The Angus Sinclair Company is also engaged in the publication of books dealing with railroad engineering subjects.

Consider General Sheridan, whose army, in his absence in Washington where he had been called for consultation, suffered defeat at Cedar Creek and had been driven off the field, but not in defeat. Returning, he met the fugitives and rallied them with the cry, "Face the other way, boys!" He stopped the retreat, reformed his troops and turned defeat into a brilliant victory by pure force of personality, combined with great courage and painstaking skill. Such is the quality of leadership and the potency of organization.

PART IV

FORMS, ACCOUNTS, AND STATISTICS

I have but one lamp by which my feet are guided and that is the lamp of experience. I know of no way of judging of the future save by the past.—PATRICK HENRY, 1776.

It is useless simply to know things as they are; we want to know what they will be, and we have no means of guessing what their future will be unless we know what they were, whence they came, how they travelled and why they moved.—A. F. POLLARD, 1921.

PART IV

FORMS, ACCOUNTS, AND STATISTICS

The forms are the sheets upon which orders, instructions, or authorizations are conveyed, or upon which information is collected, tabulated, and reported to the proper officer.

The accounts contain the final results; they should enable the final cost to be set against the work done. They should include all necessary information to show the economy and efficiency, or the reverse, with which the business is conducted. They should guard not only against dishonesty but against error.

Statistics are the accurate, systematic, and concisely tabulated information prepared from the forms and accounts.

Forms

122. Forms.—When I received my appointment as general manager, we had in use in the transportation department more than 1500 forms. During five years, by systematic work, abandoning the use of some and consolidating others, we reduced the number to 576 and still felt that very much remained to be done.

Neither here nor in the general railroad practice has there been that sharp differentiation between the financial and physical data that would have greatly clarified matters. Too little attention has been given to the physical units, the men, equipment, and traffic, in their various relations, which most nearly represent the results for which the operating officer is responsible. Each is necessary and each should have proper representation.

Much study had been given to some phases of the matter by the Committee of Statistical Inquiry of the American Railway Association, and countless varieties of experience had been had on the many roads of the country. When Professor Cunningham was appointed in the United States

Railroad Administration, he had both the advantage of this experience and plenary power to deal with it. He had, too, made a study of foreign practice and brought over the English custom of accounting for locomotive hours. Very wisely he correlated the work with the accounting practice prescribed by the Interstate Commerce Commission. His purpose, he said, was to secure the basic data and the significant averages, ratios, or unit costs which relate to, or furnish indices of, operating efficiency by the use of uniform bases, methods, and forms which would insure uniformity in practice; and this for the information both of the superior officers and the local officers, keeping them informed not only of their own results, but also as to those of other roads with which comparisons might be fairly made. This was, of course, already the practice on the large, well-organized systems, but now it was prescribed upon a national scale.

I think these U. S. R. R. A. forms may fairly be said to reflect the point of view of one lacking personal familiarity with operating details, a student of statistics rather than an active officer responsible for performance. They are of value rather as a monthly summary, for which indeed they were intended, than as a daily check. Though in some respects extravagant in detail, on the whole it was a good piece of work, and care should be taken in modifying or improving, particularly in adapting it to the day's work and to the use of the local officer, to preserve its uniformity.

The forms now in use in conducting transportation number approximately:

Supervision	12	
Car Performance	40	
Locomotive Performance	12	
Train Performance	43	
Train Movement	23	
Yard Service	20	
Station Service	144	report blanks
	80	miscellaneous
Pay Rolls Time Returns	23	
Miscellaneous	79	
Total	476	

It is felt that this number can be reduced by 20 per cent or by, say, 100 forms. The station service alone uses revenue forms. Some of the station service forms and all of the others are disbursement forms or information forms. Local officers have a very bad habit of originating numerous forms by hectograph and other processes, differing frequently in but small degree from the standard form. It would be well to enforce a rule that without special authority no forms or blanks other than the standard may be used.

Some of the forms now made daily could as well be filled out weekly or monthly. Some should be designed for collection in binders and some for information carried forward from week to week or from month to month. Many of the forms are filled out by men little skilled in writing and in the use of figures; and many are prepared under severe conditions of weather and exposure. They should be designed with consideration of these facts. Much more should be done than is done in instructing the men in the preparation of the forms and the difficulties resulting from faulty preparation. Once when a new time sheet had gone into effect one of my best section foreman asked me over to his house for supper, and with some embarrassment explained that he could not write, that his wife made up his reports and that she had had no instruction in fractions. Having first relieved their minds, I spent a most satisfactory evening going over with them the whole matter of section forms and reports and subsequently went systematically over the line, checking up the matter on each section.

There are few forms that give more trouble than the Conductor's Wheel Report, and few are made out under more different kinds of difficulty nor has the initial data yet been put in simple, usuable form. When we find them coming in bad shape from a conductor we first go over the matter with him. If this does not effect an improvement, we have him spend a few hours in the car record office. After he sees the rapid and complex course of his reports through the office, the value, and the use made of them,

he may be depended upon to respond to the call made upon him.

The forms present an endless opportunity for intelligent, coöperative work. All interested in their preparation and use should together systematically work them over, having in mind the economical adjustment of their size to the commercial sizes of paper in the printer's stock, the kind of papers to be used, the style of type, the arrangement of the make-up, the convenience of making the proper entries, the drawing of them off, and the final filing.

Every form should carry instructions as to its make-up and the officer to whom it is to be transmitted. Generally it should be a self-contained document, carrying complete instructions to every one having to do with it.

As the entries in the accounts are made from data furnished upon the forms, their accuracy depends upon the care and fidelity with which these data are collected and set down. If vague, careless, or erroneous statements are made in the beginning, then whatever follows reflects these errors. The forms provide the basis for the accounts and statistics, and extreme care should be used in correctly reporting thereon the information required regarding the company's affairs. As I am fond of saying: "If you are satisfied to find the diameter of a circle by so rough a means of approximation as pacing it off, it is a waste of time to calculate its area to four decimal places." Yet we see substantially this type of error constantly committed in our daily transactions.

All should be carefully educated and trained in the use of the forms and imbued with their responsibility in handling them.

Accounts

123. Relationship of Auditor to Transportation.—There is an intimacy in the relationship of the auditor and his accountants with the other departments of the railroad service which is much more direct and pervasive than are

the relationships between one and another of the other department chiefs, and his work carries with it a penetration into the several departments that is quite distinctive. On the other hand, the personal and official intimacy that exists between the other departments is singularly lacking in the relationship between the auditor and his accountants and the officers and employees of the other departments. It is very much to the interest of the railroad service that this condition, which is in some respects harmful, should be corrected, and it cannot be corrected unless the reasons for it are understood and the proper means to overcome it known.

In the early days of railroading the jurisdiction of the average officer was so limited, and the details with which he had to deal were so comparatively few, that he was to a very large extent able to do his own accounting. A generation ago railroad accounting was a simple matter. As division engineer, I had a road and bridge material clerk, but I made out the pay rolls, handled the correspondence and the rest of the office duties myself. As the business developed this was no longer possible and the entire accounting of the railroads was drafted into one department. To-day the work is most elaborate and is only got through with by the aid of much office machinery. Beyond question the change in the practice was not only desirable but unavoidable. To a considerable extent the irritation on the part of the operating officer is a natural consequence of the loss of control over work that was until lately fully under his jurisdiction. What should be done is to make the change as agreeably and as promptly as possible.

A further reason for the existing disharmony is the lack of acquaintance and familiarity of both sets of officers with the problems and difficulties of their associates. In the two great maintenance departments the problems presented involve an acquaintance with mathematics and the laws of physics, which form the basis of the technical education of the officers employed in each, so that the tools they use and their habits of mind are alike, making easy comprehen-

sion on the part of one of the work of the other. Not to so great an extent, but still measureably so, this is true of the two maintenance departments and the transportation department. The division engineer, in arranging for his ballasting, distribution of ties and rails, putting in new bridges, and many other activities, is compelled to consult the train schedules and reconcile his interests with those of the transportation officer, and similarly, the transportation officer has to modify his own movements to meet these demands and is led to consider them in detail and familiarize himself with them. Thus these officers come to have the same intellectual outlook and to speak the same language; they have a common stock of experience and understand each other when they exchange ideas.

There is no such relationship between the officers of the accounting department and those of the other departments. Bookkeeping is to the average operating officer an esoteric mystery with which he is not in the way of becoming familiar unless he deliberately acquires a new and highly technical and difficult art. On the other hand, the accounting staff has neither the foundation of technical training nor experience in transportation movements that supply a base on which it can build up a body of knowledge. Much attention will have to be given to broadening the fields of knowledge of both parties. The situation, with these inherent and initial disadvantages, accentuated by changing conditions, is further disturbed by the Interstate Commerce Commission. In putting into effect the accounting rules made effective by the Commission on July 1, 1907, their statistician, Professor Henry C. Adams, called together the accounting staff of the Commission and, among other things, said to them: "The Government has recently undertaken to do something quite different from that which it has ever undertaken to do before. It has undertaken to exercise a controlling influence upon the administration of railway properties through the agency of their accounts. The aim of the supervision of accounting is to exercise influence upon the administration and management of railway

property." This attitude still exerts its harmful force on the morale of the service.

Not only was this attitude assumed, but a provision of the law was taken advantage of to promulgate the idea that the auditor is not so much an officer of the railroad company as a responsible officer of the government, and that failure to obey the instructions of the Commission may lead to fine or imprisonment. It would be, perhaps, too much to say that railroad operations can be controlled through the accounts. That would be to make the history of the fact the actuating force bringing the facts into existence. In railroad practice, time, space, and matter cannot be made to assume these relations, whatever we may think of Einstein's theory of relativity.

It is needless to say that the attitude of the railroad executives was heartily opposed to this assumption of power, both in letter and in spirit. Professor Adams went on to say: "I do not know whether what I have said was consciously recognized by the members of the Interstate Commerce Commission when they framed the order under which the operating accounts were promulgated."

Happily, the Commission took much the same view of the matter as was taken by the railroad executives and sought to use its powers in the regulation of the carriers rather than in the management of their business. Notwithstanding this, much harm was done, and still to too great an extent the outlook of individual members of the staff of the Commission is in this direction.

It is of the very first importance, if I rightly apprehend the situation, that we—every one—set ourselves resolutely to work to put all these matters in their right relation; and I, myself, think few things are more important, looking to the improvement of railroad practice and the success of the transportation interests from the standpoint both of the public and the owners. As a means to this end, I believe every opportunity should be taken to bring the officers into personal contact on inspection trips, at staff meetings, at the meetings of the technical organizations; in short, wher-

ever opportunity offers. Much more important than this is the avoidance, wherever possible, of letter writing and the substitution of the warmth and sympathy of personal explanation. It might quite well be that this would have the appearance of adding to the work of men already overtaxed, but I am satisfied it would shortly have the effect of materially reducing the volume of work. Whether this were so or not, it would be, in my opinion, the most effective way to correct the conditions to which I have alluded.

It is inevitable that with the continued growth of the business, in volume and complexity, the work of the auditor should grow in authority, influence, and usefulness. We who are in a position to influence this growth should be foresighted, diligent, and patient in working out the details and fitting them into place, and especially in encouraging and forming those personal relations that will so powerfully aid in their final success.

124. Accounting.—Accounting is a systematic record of business transactions. Men of business practiced accounting in the days when the hanging gardens of Babylon were one of the seven wonders of the world.

The decline of civilization after the fall of the Roman Empire reduced trade to a system of barter. It is not much above a hundred years since the transactions between the shopkeeper and the customer were recorded by nicks on thin flat sticks, one retained by the shopkeeper and the other by the customer, a knife cut being made when they were laid together, so that the accuracy of the account might be insured.

About the beginning of the last century the system of single-entry bookkeeping (simply recording moneys received and moneys expended) came into general use. Its outstanding defect was its failure to provide an automatic check upon the clerical accuracy of the record.

From 1843 to 1845 numerous corporations were formed and there was a great growth of credit, with the necessity of tracing the movement of credit, so that the mere entry of receipts and payments no longer sufficed.

This necessity led to the rediscovery and development of the double-entry system, and the literature of that decade is filled with discussions of its advantages and complications. The essential principle of double-entry is that the receipt of a benefit and the imparting of a benefit are entered in equal amounts upon the debit and credit sides of the ledger, and the debits and credits agree if the entries are correctly made. As the young lady of the chorus said, in explaining her bookkeeping course in the night school, she "hadn't found out much about it yet, but she had found out that when you put a thing down on one page, you put something down on the opposite page to contradict it." An additional check is the continuity of statements of transferences of moneys or money's worth; of profits and losses and the disclosure of the net result of the conduct of the whole business.

An important item not necessarily disclosed by the accounts is the loss or waste that may gradually affect the assets. A transaction also may be altogether omitted and the balance will not disclose this, so that the validity of the accounts must be checked by an audit.

Each bookkeeping transaction is recorded in three columns, showing the date, the nature of the transaction, and its money value.

The accounts should be so arranged as to show a maximum of record with a minimum of labor; they should guard against dishonesty, provide a systematic record, and be a storehouse of that information upon which must be predicated changes in the property, its equipment and operation, variations in procedure, and shifts in policy. The entire process seems complicated and involved to the uninitiated, affording, like Mrs. Todger's wooden leg, "scope for the exercise of respectful wonder."

About 1862 Thomas D. Messler, at that time connected with Winslow Lanier & Co., of New York, who were the transfer agents for many of the lines in what is now known as Central Freight Association territory, left their service to become the chief accounting officer of the Pittsburgh, Fort Wayne & Chicago Railway Company. He introduced

a system of accounting which varied in many ways from the systems then used, and which was rapidly adopted by many of the railroads in the West. The system was based upon the theory that the accounts of a corporation should be a "pen picture" of the workings and financial condition of the company's affairs. All transactions which had a money value were to be reported to, and properly classified by, the accounting department. Prior to the inauguration of this system, each department or each division, as the case might be, maintained a force of bookkeepers to evidence the transaction of its affairs, and the treasurer or auditor made a summary of these several accounts and prepared a balance sheet.

A principal object which Mr. Messler had in mind was the consolidation in one department of the service of the bookkeeping and auditing of the accounting, thereby producing a uniform classification of revenues and expenditures. The accounting department was further charged with conducting the settlement of all accounts due by, or to, the company, and became responsible for the collection of all moneys due to the company until the money was lodged in the hands of the treasurer.

The principal features of the Messler system were as follows:

1. The accounting officer was made responsible for collecting all accounts due the company and for making settlements with other companies.
2. The forwarded basis for the settlement of interline freight accounts was established, and the balance of station accounts between the forwarding and receiving stations.
3. A classification of operating expenses by departments.
4. All accounts payable and journal vouchers were required to be signed by three persons, the clerk originating the voucher, his immediate superior, and the head of the department interested, before being journalized.

The Interstate Commerce Commission was organized in 1887, and the formulation of a schedule for the annual reports to be obtained from the railways was undertaken at

an early date. Invitation was issued to all carriers affected, to the various state railroad commissioners, and to other persons supposed to be interested, to meet with the Commission on October 26, 1887, in conference concerning the general subject or to submit such suggestions as might occur to them. Meanwhile, the Association of American Railway Accounting Officers was formed and took an active part in the discussion. A schedule was prepared by C. C. McCain, who organized and was then in charge of the department of statistics in the office of the Commission, and which was formally adopted at a meeting with railway accounting officers held in Washington on March 28, 1888. While the practices on the several roads, including the "Saratoga" and other systems, influenced the result, the Messler system was the one most generally in vogue, and, with some minor changes, the classification adopted was that of the Pennsylvania Lines West of Pittsburgh.

When I was general manager of the Pennsylvania Lines West and came to be responsible for their expenses, I found myself embarrassed in arriving at any intelligent conclusion by the defects of the accounting scheme, particularly in the following details:

1. There was included under "Conducting Transportation" both the expense of soliciting the traffic and of handling it.
2. There was no uniform nomenclature as to employees, and divergencies in titles gave rise to divergencies in charges.
3. There was no classified index of material, and this caused great divergencies in charging out material in local offices.

I was therefore forced to a complete revision of the book of instructions covering accounting, subject, of course, to the restrictions imposed by the Interstate Commerce accounting system. In the main we were able to overcome the difficulties above enumerated. When I went to the Baltimore & Ohio as president, where I had a freer hand, we went still further in this direction, and when I went to the Rock Island we recast the books of accounts on those properties, instituting a uniform system over the lines which had

so recently been brought under one control: the Chicago, Rock Island & Pacific Railway; Burlington, Cedar Rapids & Northern Railroad; Choctaw, Oklahoma & Gulf Railroad; St. Louis, Kansas City & Colorado Railroad; St. Louis & San Francisco Railroad; Chicago & Eastern Illinois Railroad; Evansville & Terre Haute Railroad; Southeastern Missouri Railway, and perhaps some others.

In 1906 Professor Adams began work upon a plan for recasting the Interstate Commerce Commission classification of operating expenses under the provisions of the Hepburn Act, taking the matter up with the Association of American Railway Accounting Officers. As Frank Nay, then chief accounting officer of the Rock Island, was president of that Association, and as he had, besides its influence, the hearty support of the Pennsylvania, Baltimore & Ohio, Chesapeake & Ohio, Norfolk & Western, and some other companies, the accounting system of the Rock Island was taken as a basis for discussion, and with modifications was the system adopted.

Thus all accounts are now prescribed by the Interstate Commerce Commission and kept in accordance with its instructions, it having from time to time issued some ten or more classifications.

A prescribed account may be subdivided in order to show information in greater detail, but it may not be combined with other accounts so that its identity is lost. Penalties of fines and imprisonment are prescribed for making false entries, or failure or neglect to make proper entries in accounts or records, or mutilating the same. At the time when the legislative hostility to the railroads was at the height of its ferocious aggressions, the Interstate Commerce Commission was given power to forbid the carriers to keep any account or memorandum not specifically authorized by them. This extreme arbitrary power was happily never exercised.

The great defect of the Interstate Commerce Commission classification of accounts is its meticulous detail and lack of balance. Some of the accounts involve sums of money

so small as to be almost microscopic when compared with the total, while some of the larger items could be subdivided to advantage. The arrangement is illogical; in some sense, inconsistent. The main source of trouble would seem to be the attempt to initiate a method of cost accounting on lines similar to those used by manufacturing plants. The experiment has been very costly, is productive of no results justifying the expense, and should be promptly abandoned.

125. Audits and Inventories.—An important item not disclosed by the accounts is the loss or waste that may gradually affect the assets; also, while a transaction may be altogether omitted, the balance will not disclose this, so that the validity of the accounts must be checked by an audit. This concerns itself with seeing that the cash on hand, securities, etc., as well as the items of materials, supplies, equipment, and other physical units standing upon the books are actually to be found upon the property or in the treasury; that proper provision has been made against loss or waste that may gradually accrue in the assets; that transactions which have occurred have not been omitted from the accounts; and that the various expenditures have been properly authorized, or covered by contract requirements, or otherwise.

The cash and securities in the hands of the treasurer at the close of the fiscal year are, shortly after that date, examined by a committee of the board of directors by actual count and by comparison with certificates of deposits and pass books to make sure that the same agree with the amounts called for by the ledger balances. This committee also examines the income and profit and loss accounts, and makes sure that they are in accordance with the books of the company, and examines the balance sheet and makes certificate that it is a true and correct exhibit of the accounts of the company at the close of the books as shown by the general ledgers.

While no one would look for the disappearance of the land or the large structures, such as large terminal freight stations, or terminal yards, there is in every property a large

number of comparatively small units, such as torpedoes, lanterns, etc., and in order correctly to relate these to the accounts it is necessary to take recurring inventories which ought not to be at longer intervals than twelve months and which look to the identification and checking of all material of this character, as well as rail, ties, fuel, locomotives, cars, etc.

While the inventorying of material stored at a particular point is a comparatively simple matter, and no particular difficulty arises as to locomotives and passenger cars which remain on the property, an inventory of the rolling stock, which is constantly moving from place to place throughout the country, is not so simple, nor is it generally understood.

Usually there is obtained from the auditor the last statement of Official Inventory of Equipment Owned which shows all cars carried on the books of the railroad as an asset. The cars shown in the Official Inventory of Equipment Owned are checked for such cars as cannot be seen against the car record books currently in use in the office of the superintendent of car service. The check looks to the finding of a car of the same initial and number, together with what is called a "good record"; that is, one plainly indicating that such a car is in existence and moving currently.

Home cars on foreign rails are similarly checked against information shown in the book in which is recorded the advice of foreign roads as to receipts of cars from one road and deliveries to another.

On home roads "poor records" (those showing more than thirty days' delay or those not conforming to customary train runs) are then checked against yard or station reports of cars on hand. The remainder, together with any suspicious cases, are subject to personal inspection at the point where the last record shows them to be located. "Poor records" on foreign lines are then made the subject of inquiry as to actual existence of the cars and the reason for the delays.

The residue from this operation is checked against the

information shown in a History of Equipment Record Book maintained in the office of the master car builder or other officer responsible for the maintenance of the equipment. This book contains a record of equipment as purchased or built, together with all units destroyed, torn down or renumbered, etc.

The checks above referred to result in discovery of cars not actually in existence but included in inventory and cars actually in existence but not included in inventory, making it possible to correct the History of Equipment Record Book and current car record books.

Each item of equipment which cannot be satisfactorily identified is made the subject of special investigation. The results obtained from these investigations depend largely upon the experience of the men engaged and the degree of their ingenuity; also the adequacy of the necessary records, such as wreck reports, etc., at the offices of division master mechanics, master car builders, yardmasters, etc.

Cars disappear under a large variety of conditions. Some are destroyed in yards without any reports (intentionally or unintentionally) being made. Others may be repainted and renumbered by industries or other railroads, or by contracting firms on either home or foreign lines, and moved, under the new marks, to new jobs on other roads. Others, particularly when in a dilapidated condition, may be left in obscure locations, or shoved off the end of a track which has been subsequently removed; they may have been appropriated and dismantled by scrap dealers having track connections with the railroad; and some of the older types of open top cars are sometimes found completely buried under refuse at the end of freight-house platform tracks or other locations where they were once used as refuse cars. Car bodies are taken off trucks, assembled in ingenious order for use as homes for section men, or for small offices at out of the way points without any record thereof being made. It will readily be seen that a penetrating inventory of equipment is a very important essential, not only in order to protect the company's

property, but also to provide the proper measure of this particular asset in the accounts.

126. The Grand Audit and Valuation.—The value of the railroad as justifying its capital issues, bonds, equipment trust notes, stocks, etc., has been a popular subject of discussion for a generation. As early as 1888 the Interstate Commerce Commission began to discuss in its annual reports the advisability of making a valuation of the railroads of the country, and in 1903 it first recommended to Congress that it be authorized to undertake a determination of the matter; and finally on March 1, 1913, an act was passed providing for what has come to be called the Federal Valuation. It was then estimated by the Commission that the cost would be between $2,000,000 and $5,000,000 and that the work would be completed in from three to five years. Already eight years have elapsed, more than $60,000,000 have been expended by the government and the railroads, and it is plain that the end is not in sight. The act requires the finding of "the original cost to date" by the inventory method, that is, a determination on the ground of the various components of the property and the subsequent identification of them in the records of the company. Usually about 85 per cent of the total cost may be identified, it being necessary to estimate the cost of reconstructing the remainder by the usual engineering methods. The act requires the finding of the "cost of reproduction new," including the cost of the acquisition of land. This is done by the customary engineering method and is likely to reflect the vice of engineering estimates by being 10 per cent to 20 per cent too low. The determination of quantities, though a work of prodigious detail, is readily checked, and the results may be considered accurate, but the prices to be applied are matters of judgment and admit of destructive variety. Some of the initial assumptions, such as duration of construction, interest during construction, and cost of lands, are open to similar objections. The final results will, therefore, beyond peradventure be challenged. The act requires the finding of the "cost of reproduction new less

depreciation" which I shall refer to later, and, further, it requires the finding of "other values and elements of value," of which there have been suggested among others, "going concern value," "value of unity of use," "franchise value," "location value-traffic," "location value-operation," etc. Finally the Interstate Commerce Commission is to determine "the value" of the railroad.

If we keep in mind that:

"Price" is what the seller obtains for his goods in the market;
"Cost" is the amount paid or engaged to be paid for some thing or some service;
"Value" is what a thing will fetch, the purchaser not being under compulsion to buy nor the seller under compulsion to sell; ?

and recall Samuel Johnson's famous statement when he auctioned Thrale's effects, "We are not here to sell a parcel of boilers and vats but the potentiality of growing rich beyond the dreams of avarice," we may form some idea of the problem the Commission has in fixing the value of the railroad as a "going concern" in the enjoyment of a business carried under rates fixed by the Commission, and under wages and rules governing the conditions of employment of its forces fixed by the United States Railroad Labor Board.

In April, 1910, the British Parliament passed an act looking to the valuation of the lands of the kingdom. After ten years of work and the expenditure of $25,000,000, in July, 1920, the Chancellor of the Exchequer advised that the report of the deputy chairman of the Board of Inland Revenue was a "cold and damning document; an absolutely damning document"; that the plan was unworkable and the results "useless; that the right thing to do was to recognize facts, to admit failures, and to act like sensible men"; and upon his motion the act was repealed. What will be the ultimate fate of our much more ambitious effort, it is too early to attempt to forecast.

One thing at least is clear. It is no longer contended in any responsible quarter that the railroads of the United States as a whole on June 30, 1914, when construction costs were at their lowest, could have been reproduced for the sum at which they were carried as assets on the books of the owning companies. As much might have been apparent to any honest mind from the contemplation of the figures shown on Fig. 28.

In giving effect to the Transportation Act, 1920, the Interstate Commerce Commission placed, for the purposes of that particular case, the value of the steam railway property of the carriers subject to the act held for and used in the service of transportation, at approximately $18,900,000,000. It is quite safe to say that at the then level of wages and prices of material this property could not have been reproduced for $40,000,000,000. What other business could have sustained such a blow and have survived?

The word "water" is one of the words the real meaning of which has not been generally understood and the skillful use of which by the demagogue has inflamed the community to the point of destructive hysteria. It is a sad commentary on human intelligence that the controversies of the last generation with their destructive force, the full effect of which has not even yet been felt, might have been avoided had the laws originally made possible, as they now do, the issue of stock without par value, instead of requiring that stock should be issued as of a value fixed in the certificate.

Whatever may be the cost of the creation of a productive enterprise, its value is to be found in its activity as a going concern, the way in which the forces are assembled, the use made of the plant, the skill with which the merchandising is conducted; in other words, upon the capacity of the management.

If the conditions of legislation were such that the field for the display of enterprise was to be found only in a body described as "water," analogy might at least have suggested the essential part played by that element in all

FIG. 28.—STATISTICS OF UNITED STATES RAILWAYS

	1873	Per Mile of Single Track	1892	Per Mile of Single Track	1906	Per Mile of Single Track	1916	Per Mile of Single Track
Miles of single track	70,268	.....	171,564	......	222,340	......	259,211	.....
Miles of second track	....	.....	9,367	......	17,936	......	28,935	.....
Miles of third track	....	.....	853	......	1,766	......	2,731	.....
Miles of fourth track	....	.....	626	......	1,260	......	2,198	.....
Total all main tracks	....	.....	182,410	......	243,302	......	293,075	.....
Yard and sidings	18,874[1]	.....	39,941	......	73,761	......	101,869	.....
Total mileage operated (Total trackage)	89,142		222,351		317,063		394,944	
Number of locomotives	12,946	0.18	34,626	0.20	55,439	0.25	65,314	0.25
Number of passenger cars	13,004	0.18	24,604	0.14	33,896	0.15	54,774	0.21
Number of freight cars	345,788	4.90	1,177,113	6.90	1,976,667	8.90	2,342,217	9.00
Number of tons carried	175,733,795	2,501	706,555,471	4,118	1,631,374,219	7,337	2,223,281,182	8,577
Number of passengers carried	157,873,169	2,245	575,769,678	3,354	815,774,118	3,669	1,005,683,174	3,879
Total ton miles	....	.....	88,241,050,225	514,333	215,877,551,241	970,934	343,099,937,805	1,323,631
Total passenger miles	....	.....	13,362,898,299	77,889	25,167,240,831	113,192	34,213,596,127	131,991
Total traffic units	....	.....	101,603,948,524	592,222	241,044,792,072	1,084,126	377,313,533,932	1,455,622
Book cost of road and equipment	3,784,543,034[2]	53,859	8,738,533,165	50,934	12,420,287,938	55,861	17,525,576,908	67,611
Capital provision per traffic unit	....	.....	0.086	......	0.052	......	0.046	.....
Charge to public per traffic unit[3]	....	.....	0.011	......	0.009	......	0.009	.....

[1] All other tracks.

[2] Book cost of road and equipment for 1873 not available. The figure shown is the total of the capital stock and funded debt outstanding.

[3] This figure of charge to the public per unit of traffic moved is in excess of the actual charge, because it carries the service of mails, express elevators, demurrage and miscellaneous earnings, which the statistics do not permit of readily eliminating.

SOURCE: *Poor's Manual* and I. C. C. reports.

our activities from the maintenance of life to the irrigation of the arid regions. It was not something at which to be frightened, but rather something to be studied and comprehended.

127. Depreciation.—One of the important functions of an audit is to safeguard the accounts from the insidious impairment that may gradually affect the assets. The English describe this by a most meaning phrase: "wasting assets." One may readily see that if a corporation were to buy coal lands containing 4000 tons of recoverable coal to the acre, paying therefor $100 per acre, that as the mining proceeded, unless the coal removed—the "wasting asset"—were charged out of the assets at 2½ cents per ton, the books would no longer reflect the true condition of the property. In many enterprises this is a matter of the very first importance, and the most careful attention must be given to it. The railroad is a composite of many different parts, and of these there are many units which, especially as the road becomes of large size, tend to fall into a routine of rhythmic replacements, such as ties, rails, bridges, buildings, cars, locomotives, etc. Here it is impossible intelligently to divide the maintenance account into repairs and depreciation. If the theory of depreciation is carried to its logical extreme, there is nothing left for repairs; if repairs are adequately made, there is no depreciation.

Let us consider the locomotive, consisting of some 15,000 parts, many of them duplicates and all of them replaceable. When this machine is received from the builders it has to be "tuned up" and put in shape for service. Assuming this condition as 100 per cent, it would be entirely practicable to keep the locomotive in service indefinitely by successive renewals of its parts, and this was indeed at one time the English practice. On the diagram, Figure 29, is pictured this perpetual life, the ability of the locomotive to handle its rated tonnage remaining unimpaired. The continuous changes in locomotive stock is a consequence of changes in the state of the art and are handled under the bookkeeping designation of retirement. How rapid these

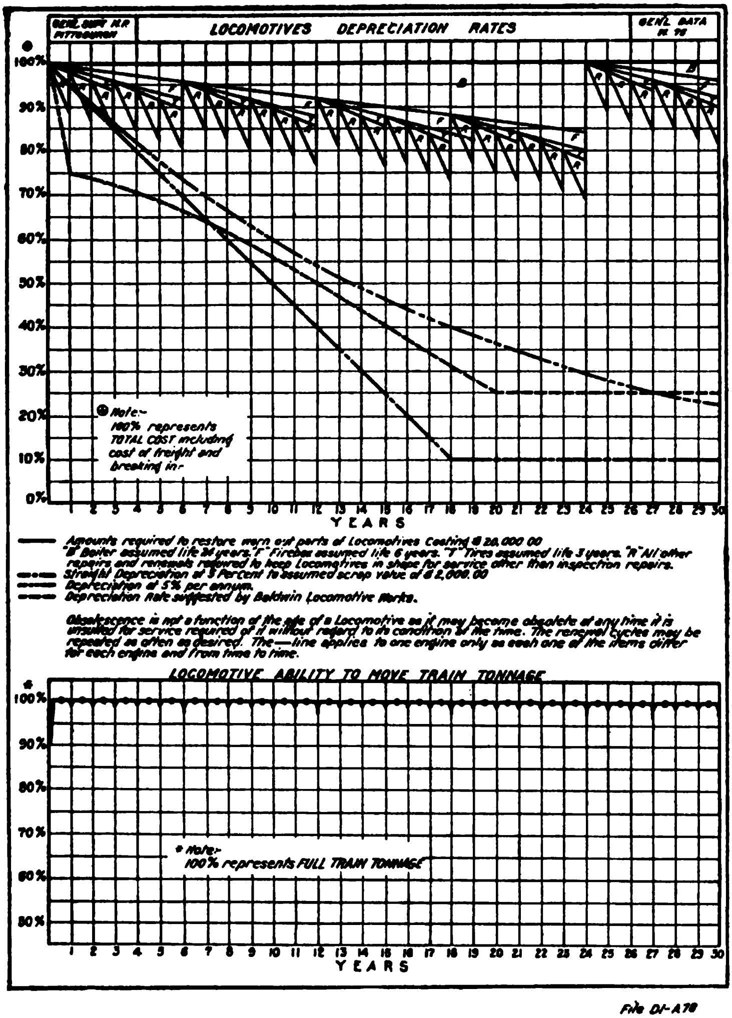

FIG. 29.—PERPETUAL LIFE OF A LOCOMOTIVE.

changes are is indicated by the history of the "999,"' the locomotive that was the outstanding feature of the exhibit of the New York Central Lines at the World's Fair at Chicago in 1893, and which then hauled their famous Empire State Express. In 1910 this engine was pulling a milk train in northern New York, and it is now in passenger service on a small branch in the Beach Creek District.

Since writing the above I have run across the following by Dr. Dionysius Lardner in his *Railway Economics*, published in 1848:

> That the value of the property which a railway company possesses and uses depends generally upon the condition of efficiency in which it is maintained and on the market value of the objects which compose it, but if capital is to be written down as prices of materials fall it should be written up as they rise. In truth, such a principle cannot be maintained. If an annual valuation or survey of stock be made, it must be upon the principle of estimating it by its quantity and efficiency only, and not by its marketable value, which is determined by causes over which the company has no control and quite independent of the use or abuse of their property.

In the Federal Valuation great confusion has arisen over this matter of depreciation. The Bureau of Valuation has not been content to look at the structures as used in their entirety, but has proceeded to dissect them beyond the point at which they could be serviceable and then to give consideration to those dismembered parts. Consider the structure of the track; it is made up of ties, rails, angle bars, track bolts, nut locks, tie plates, anchor plates, spikes, etc. But it would not be serviceable except as an integral assemblage. The test should be: "Is this structure maintained in such condition as to permit the safe transit of trains at schedule speed?" If it is, then there is no deferred maintenance, there is no depreciation, no wasting asset; it is in a condition of 100 per cent. To go beyond this and to give separate consideration to an element of the structure such as the ties, save for the sole purpose of determining

deferred maintenance, is to lose one's self in a maze from which nothing satisfactory can result.[1] No attempt is made to fix the identity, say, of a cross tie. When an old one is taken out of the track and a new one put in the Capital Account is not affected, the entire charge being made currently to Expenses; but this is not the case with locomotives. A new locomotive is given a number which is entered in the stock book and thereafter its life is accounted for. The Kansas City Southern Railway Company in September, 1903, bought a locomotive which it numbered "453" and entered it in its stock book at its cost price of $19,397. The Interstate Commerce Commission upon inspecting the engine valued it as of June 30, 1914, at $17,597. The locomotive stood on the books on April 25, 1917, as having a value of $13,542. It was sold on that date for $21,015.

The railroad business is not one which happily lends itself to theorizing. One may indulge in speculation and embalm in the records the results of his imaginative enterprise, but too often the subsequent effects will make him seem ridiculous. As Josh Billings says: "It ain't so much people's ignorance that does the harm as their knowing

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[1] John Stuart Mill in his book, *Principles of Political Economy*, says:

The greater part, in value, of the wealth now existing in England has been produced by human hands within the last twelve months. A very small proportion indeed of that large aggregate was in existence ten years ago; of the present productive capital of the country scarcely any part except farmhouses and manufactories, and a few ships and machines; and even these would not in most cases have survived so long, if fresh labor had not been employed within that period in putting them into repair. The land subsists, and the land is almost the only thing that subsists. Everything which is produced perishes, and most things very quickly. Most kinds of capital are not fitted by their nature to be long preserved. There are a few, and but a few productions, capable of a very prolonged existence. Westminster Abbey has lasted many centuries, with occasional repairs; some Grecian sculptures have existed above two thousand years; the Pyramids perhaps double or treble that time. But these were objects devoted to unproductive use. If we except bridges and aqueducts (to which may in some countries be added tanks and embankments), there are a few instances of any edifice applied to industrial purposes which has been of great duration; such buildings do not hold out against wear and tear, nor is it good economy to construct them of the solidity necessary for permanency. Capital is kept in existence from age to age not by preservation, but by perpetual reproduction; every part of it is used and destroyed, generally very soon after it is produced, but those who consume it are employed meanwhile in producing more.

so darned much that ain't so." This item of depreciation which may be pictured as running as high as 15 to 25 per cent of the total replacement cost of a railroad has been so used by those who seek to depreciate the value of railroad property as to demand the closest study.

My father used to tell me, for my instruction, a story to this effect: In his time, as was the case when I was a lad, the slaughtering of cattle was done locally. A butcher had a barn on the outskirts of town. To a beam in the roof was attached a pulley, to the floor directly beneath was fastened a ring. A rope was placed round the horns of the steer and the free end passed through the ring and over the pulley. By drawing on it the head of the steer was forced down to the floor. The assistant held the head firm by grasping the horns and the butcher dispatched the steer by slugging it between the eyes with a sledge. On this occasion the butcher was cross-eyed and the assistant a negro. As the fatal blow was about to be delivered, the negro, looking up, got a terrific fright and shouted "Say, boss, is you goin' to hit where you look? 'Cause if you is ah'm goin' to run."

Astigmatism of the mental vision would appear to be an even more common failing than astigmatism of the optic vision and, while the latter seldom affects anything but personal appearance, the former is always devastating in its destructiveness. Like the old detective who said he just naturally hated a thief, I just naturally hate a cross-eyed mind. You may be sure the man who has one will never hit where he looks.

128. Obsolescence and Retirement.—The expense account of a railroad may be subject to sharp fluctuations by the replacement of structures of considerable magnitude, such as bridges and stations, or by the premature retirement in considerable numbers of locomotives, cars, etc., due to the rapid development of the "state of the art," and by property abandoned due to relocation of line, etc. To protect the credit of the companies an equalization account for a specified purpose and a definite number of years may

well be set up to spread the effect of these unusual and unforeseen charges.

Generally speaking, it may be said that all accounting may be divided into three classes, revenues, disbursements, and general. For the information that follows concerning the details of transportation accounting, I am indebted to W. E. Eppler, Comptroller of the Delaware and Hudson Company.

129. Revenue Accounting.—What a railroad has to sell is transportation, and this is a commodity which cannot be stored. If produced in excess of the amount demanded, the excess is wasted. The carrier markets its commodity through the medium of its many agents, and it is sold in three different forms, represented by revenue from three different sources, freight, passenger, and incidental. The accounts must show the amount of money which the carrier becomes entitled to receive; also the source of the return. The final returns are handled through Income Account 501, Railway Operating Revenues, which is the net result of statements made under 27 headings, some of which cover incidents of freight transportation.

130. Accounting for Freight Revenue.—Rates for the transportation of freight are prescribed in tariffs written by the traffic department and filed with the Interstate Commerce Commission and the various state commissions. These tariffs are furnished to the agents and are publicly displayed at the freight depots. No transportation service can be rendered or rates quoted which are not covered by such lawfully published tariffs.

For each shipment accepted for transportation a contract in the form of a bill of lading is issued. The original is given to the shipper as a receipt for his property, and for other purposes. The copy kept by the carrier is known as a "shipping order." They are documents of much importance. The waybill is prepared from information contained on the shipping order and forms the basis for the freight revenue accounting. These waybills are of several varieties; those showing no charges being usually car movement waybills, astray way-

bills, and company freight waybills. In addition to its accounting function, the waybill furnishes to the freight conductor his authority for the movement of the freight described over all or part of the road traversed by the conductor and his train, and over all or part of the distance the shipment is to move. The conductor has no authority to move any freight not covered by the waybill, except as he may move astray freight under special instructions.

Because freight is moved not only from one point to another on the same railroad, but also from a point on one railroad to a point on another railroad; because of the establishment of through and joint rates applying over two or more railroads; because of the necessity and desirability of eliminating delays in handling freight which might arise from accounting requirements; and because of the differing financial relations and arrangements established between railroads, there has been brought about the creation of several different classes of waybills, the principal ones being: (1) local waybills, (2) junction settlement, (3) through waybills with audit office settlement (the familiar "A.O.S." billing), and (4) card waybills.

Any deviation from interline "A.O.S." billing is liable, and even quite likely, to interfere with the prompt movement of freight through the necessity of rebilling at junction points. To the extent that it is possible to do so, the railroads should promote through billing with audit office settlements, increasing such billing and settlements wherever justified.

The card waybill was adopted in order to overcome delays arising through the non-receipt of regular waybills at junction points.

Divisions of through rates are established by negotiations between the traffic departments of the roads interested, and while usually on the basis of percentages, they are frequently on the basis of specific amounts per 100 pounds or per ton. Both bases are in many cases complicated by the recognition of the claims of various railroads for allowances of fixed arbitraries. Such arbitraries are usually based upon the existence of special conditions resulting in extraordinary

terminal expense, bridge tolls, etc., and must be set up to the credit of the line to which they accrue before division of the balance is made on the basis of the established percentages.

Practically all the basic data for freight revenue accounting (as well as passenger and incidental) originate at the various stations. The station agent, in addition to his many other duties, must also be an accountant. He is responsible for all the money collected or collectible at his station. He maintains a set of books, and has an account with the auditor of revenue or other officer in charge of revenue accounting. The manner in which the station accounting is performed is compiled in a very comprehensive form in the "Book of Instructions for the Government of Agents," usually found to be in use on the more progressive railroads, which is revised constantly in order to keep the agents fully informed as to changes in methods, etc. It will be interesting, however, to go over in a general way the nature of the accounting work performed at the stations.

131. Freight Forwarded Book.—The agent records in this book only those waybills made out at his station carrying "prepaid" or "advance" charges—charging himself with the former and taking credit for the latter. He is responsible for the collection of the one and for the payment of the other. The totals of these items are used to verify similar totals appearing on the Monthly Summary of Daily Abstracts of Waybills Forwarded.

132. Freight Received Book.—Each and every waybill for freight received must be entered in this record and each consignment is shown separately in order that the record of payments and charges may be posted. Being responsible for the collection of "freight" and "advance" charges, the agent takes debit for both. Credit is taken for the amount of such of these waybills as indicate a prepayment at the forwarding station. The daily totals of "freight," "advance" charges, and prepayments are balanced with the agent's Daily Abstract of Waybills Received.

133. Freight Bills and Delivery Receipts.—As soon as waybills are received, checked, and recorded, a combination

freight bill and delivery receipt is made for each consignment. This freight bill contains a full description of the shipments and the charges due thereon, and may be compared with an invoice rendered by a merchant for goods sold or service rendered. The freight bill is the carrier's invoice for transportation sold. When payment is made, the agent furnishes a receipt therefor upon the freight bill, and delivers it with the freight. Concurrently, the consignee signs the delivery receipt which is retained by the agent as evidence of delivery. Notation of shortage or damage should be made upon both the freight bill and delivery receipt prior to execution, and this information may subsequently be of much importance to the freight claim agent in settling claims, etc. The agent posts to his cash book the amount of payments as indicated by the delivery receipts.

Prepaid freight bills are similar in form to ordinary freight bills, and are generally used in billing credit customers for freight charges prepaid at originating points. When collection is made, the agent furnishes a receipt therefor on the face of the prepaid freight bill.

134. Settlement Book.—Cash settlement for freight charges upon delivery of freight is demanded of receivers or shippers of freight, except those individuals, firms, or corporations which have made credit arrangements with the treasury department. In order to control this matter, the agent maintains a Settlement Book, wherein an account is kept for each patron having credit. As charges against the patrons accrue, they are entered in the Settlement Book and collections therefor are made periodically. There is also entered in the Settlement Book an account with each connecting carrier with which junction settlements are made. Such accounts are charged with the amount due from each carrier, representing the total charges up to his station appearing on the waybills or transfers for freight delivered thereto, and for movement beyond. Credits are posted to the account of each carrier for the total charges due them on shipments received from them for delivery or forwarding. A "due bill" is prepared periodically and

signed by the agent of each company, showing the net amount due from one to the other. Payments are then made in cash, by station draft, or through the general office.

135. Cash Book.—This is a current record of daily cash collections and disbursements made at the station. The remittances, which the agent is required to make (daily, in most cases) to the designated depository, are considered as disbursements. The difference between the various entries representing daily receipts and disbursements (after considering, of course, the balance from the previous day) furnishes the agent with the amount of his cash balance at the close of the day, which should be balanced with his actual cash on hand.

136. Miscellaneous Records and Reports.—The agent also keeps record of several other classes of transactions, such as demurrage, switching, storage, telegraph receipts, war taxes collected, etc. He renders periodical reports (daily, weekly, monthly, etc.) of all waybills issued and forwarded, and waybills received, switching charges, storage charges, demurrage charges accrued, rent collections, telegraph receipts and freight charges on Company material, miscellaneous debits representing receipts from the sale of freight, miscellaneous credits covering station relief claims, etc.

137. Proof of Station Accounts and Monthly Balance Sheet.—When he has completed his reports, balanced his cash, etc., the results of the business conducted at his station are summarized in a record called Proof of Station Accounts. This record is in reality a ledger, and from it each separate account is transferred or carried to the balance sheet, which is generally made up in the form shown on Figure 30.

In the accounting office an audit is made to see that the full revenue is received for the service performed; that proper settlements are made to and by station agents and interested foreign roads; that all charges assessed are correct from a standpoint of rate, classification, extension, and footing. As may well be seen, there is a voluminous amount of detail attached to this work, and, in order to facilitate the concentration of these data for the purpose

....COMPANY

............................STATION BALANCE SHEET, AS OF............192...

Balance due company from last month			Balance due station from last month		
Freight received—local					
Freight received—interline—A.O.S.					
Advances received—local			Advances forwarded—local		
Advances received—interline—A.O.S.			Advances forwarded—interline—A.O.S.		
Prepaid forwarded—local			Prepaid received—local		
Prepaid forwarded—interline—A.O.S.			Prepaid received—interline—A.O.S.		
Demurrage			Remittances		
Switching					
Storage—freight					
Miscellaneous debits			Miscellaneous credits		
Telegraph receipts			Freight charges on company material		
Passenger collections			General office collections		
War taxes—(various)					
Due bills			Due bills.		
Balance due station at close of month			Balance due company at close of month		

....Agent.

FIG. 30.—STATION BALANCE SHEET

of making proper disposition to the accounts, and for other purposes, use is made of several modern accounting devices, among which may particularly be mentioned the Hollerith machine.

138. Accounting for Incidental Revenue.—The two main sources of revenue are freight and passenger transportation, but in addition to these are such items as express, mail, dining service, parlor and chair cars, restaurant, demurrage, storage, excess baggage, and several other items incidental to transportation.

Accounting for incidental and passenger revenue is not nearly so burdensome as accounting for freight; nevertheless they have their complexities and in any case the carrier's interest in all of these items must be protected through proper accounting.

139. Disbursement Accounting.—As the greater part of the carrier's revenue is derived from transportation, so the greater part of its expenditures are made for transportation. The operations of a carrier are unsuccessful unless its revenues exceed its disbursements; the greater the excess the greater the success.

The tendency of most of us, I am afraid, is to spend more than we earn, and unless careful consideration is given to the amount and nature of disbursements, the weakness of the individual is likely to be reflected in the corporation.

The accounts must show the cost of conducting operations, and the manner in which such costs were brought about. The final returns are handled through Income Account 531, Railroad Operating Expenses. This account is subdivided into eight headings, as follows:

1. Maintenance of Way and Structures
2. Maintenance of Equipment
3. Traffic
4. Transportation—Rail line
5. Transportation—Water line
6. Miscellaneous Operations
7. General
8. Transportation for Investment—Credit

The fourth classification (Transportation—Rail line) is the one pertinent to the present discussions, and, in so far as it is possible to do so, my remarks will be confined to such expenses as are properly included in that account.

Without much technical knowledge of accounting, the transportation officer may here identify the familiar factors of labor, fuel, water, lubricants, station, train, engine, engine house and office supplies, damage to property, loss and damage to freight, personal injuries, and other casualties.

While the routine for handling the accounts differs widely on the several roads, the effort to secure the maximum of record within the prescribed time, and at a minimum of expense, has tended to decentralize the accounting force so as to keep it in immediate contact with the conduct of the business. With a representative of the accounting department at the headquarters of the division, or district, the story of the operations as reflected in the forms of payrolls, invoices, bills, etc., is more conveniently translated into the appropriate accounting terms; while invaluable assistance may be given the transportation officer by the prompt and intimate interpretation of the results of operations, as shown by the accounts.

Although a considerable amount of detailed accounting is performed by the division accountant, there are, nevertheless, a number of transactions that can be best accounted for under a plan of centralization. Certain requirements make it necessary to draw together all the accounts of the carrier for summarized statements, so that the more important, as well as the larger part of the accounting work, must continue to be handled at general headquarters. The accuracy and correctness of the results as indicated by the compilations of the general office are entirely dependent upon the condition of the returns rendered by the division officer, which in turn are dependent upon the information furnished by the superintendent, master mechanic, division foreman, etc.

In order to appreciate the work performed by the

accounting officials, it is necessary to have some knowledge of their responsibilities. Consider, for instance, the handling of pay rolls for officers and clerks, dispatchers, station employees, telegraph operators, and signal and interlocking men. A record of the time of each individual is kept by the officers in charge at the hundreds of stations, shops, offices, and other outlying points. Upon the accounting officer rests the final responsibility for the correctness of all of these returns. A vast number of these returns are periodically transcribed to the regular forms of time reports and transmitted to the division accountant, who, after verifying the rates and extensions, proceeds to the preparation of the necessary pay rolls covering.

Although this phase of timekeeping is a very important matter and one requiring considerable attention, it is, nevertheless, a very simple undertaking when compared with other activities of the accountants. This is due to the fact that the compensation of most of the employees mentioned above is computed on the basis of a flat rate of so much per month, per day, or per hour. Even this transaction has been somewhat complicated recently by the rules adopted during federal control, which provide for certain allowances not based entirely upon actual time employed. Another cause of accounting complications is the practice in vogue at some points of paying freight transfer employees on a tonnage basis. This system, although advantageous from an operating standpoint, involves a somewhat greater expense for timekeeping than would be the case if the ordinary method were followed.

One feature, the importance of which may never have been seriously considered by officials of the operating department, is the use made of the occupation or title of employees as indicated on the pay roll. With most of the employees mentioned above, the pay-roll "designation" determines the distribution of wages and salaries among the several primary operating expense accounts. This is also true to a certain extent with the enginemen and trainmen (to be treated in greater detail later).

With respect to maintenance of way employees and shop employees, the situation is entirely different, and in order to arrive at the proper distribution of their time, a daily time slip, giving a detailed description of the day's work, is necessary.

More complicated, involved, difficult, and burdensome is the keeping of time and preparation of pay rolls for enginemen and trainmen. An extraordinary amount of accounting is necessary, due, first, to the relatively large number of men in this class of employment, and, second, to the extremely complicated wage schedules and varying conditions under which these men labor.

Conductors render daily time slips covering services performed by themselves and the trainmen in their crews. Engineers render daily time slips covering services performed by themselves and their firemen. Each such time slip must be certified as to time off duty by yardmaster or engine dispatcher at terminals where crews go off duty, and, upon receipt in the superintendent's office, must be verified as to correctness of time going on duty, mileage, or time on duty, trips made, etc., by reference to the train and engine register sheets and dispatchers' train sheets. After this verification, time allowance and rates payable must be posted in accordance with the effective wage schedules.

Timekeeping and the preparation of pay rolls for these classes of employees is a very expensive process, and it has become a matter of concern with some railroads to find a method more economical than doing it all in the ordinary "by hand" manner. In order to solve the problem, the Hollerith sorting and tabulating machines have been resorted to. These machines are capable of producing great economies, especially when the work to be handled is of great volume. For this reason, in the use of these machines in connection with such timekeeping and pay roll work as that under discussion, it has been found advantageous, by roads otherwise using the divisional system of accounting, to abandon in a measure the effort to have all the

initial accounting work on timekeeping performed in the divisional accounting offices. The alternative has been the establishment at a central point, preferably in the office of the auditor of disbursements, of an organization equipped with an adequate number of machines and of doing all of the work there, thus producing sufficient volume to make the machines remunerative.

This question of timekeeping for enginemen and trainmen is one of vital importance to the division superintendent, and for this reason he should be thoroughly familiar with all its ramifications.

It will be seen that the objects sought and attained are:

1. The checking of time slips as to time allowances and rates.
2. The accumulation of time and allowances to enable the preparation of pay rolls.
3. The allocation of expenses to the various divisions.
4. The proper allocation of mileage.
5. The assembling of data for reports and statistics.

The amounts of the various pay rolls, and the distribution thereof among the several accounts affected, are forwarded to the division accountants for inclusion in their accounts just as though the pay rolls had been prepared in the division offices, thus maintaining the integrity of the division accounts and, at the same time, securing the advantages of a centralized system of compilation.

The division accountant, having completed his pay roll distributions, makes a summary on his "blotter," and at the end of each month takes the totals appearing on the "blotter" into his accounts through the medium of a journal entry, charging the various accounts affected and crediting his balance sheet account "pay rolls."

While nearly all the transactions accruing in one month are reflected in the accounts for that month, there is a class of charges, such as those covered by telephone and electric light bills, joint facility bills to be paid or collected, and other bills and charges of a recurring character, which are not usually received in time to be handled in the current

month's account. There is also a class of charges, such as loss of and damage to freight, personal injuries, etc., which, due to their peculiarities, are given special handling in order that their irregular nature may not distort the figures. Briefly, they are handled in the aggregate rather than specifically.

The practice of the division accountant is to record in appropriate "blotters" or "registers" (a separate one for each class of transaction) the pay rolls, invoices, bills from other divisions or departments, debit or credit advices from the auditor of disbursements, etc. Each such "blotter" shows the proper distribution among the several operating expenses and other accounts affected, and the totals show the distribution of the total amount of each class of transactions. Then each of these is either actually or in effect made the subject of a journal entry, and a summary is prepared in order to gather for each individual account the charges and credits from all sources made thereto. This summary, whether or not it be in book form, is the equivalent of a ledger, and from it is drawn the balance sheet.

On the credit side of the balance sheet there will appear an item entitled Transportation—Rail line, which represents the transportation expense of the division for a given month or period. The "blotter" produces a distribution of such amount by primary accounts, and such distribution is put up in the form of a supplementary statement supporting that item on the balance sheet.

When this point has been reached, we may say that most of the physical units, the results of the efforts of the transportation officers, are reflected in dollars and cents. It is here that the transportation officers may see the actual results of their work. Taken by themselves, the results as portrayed by the division accountants have a limited value to the transportation officer unless he is somewhat familiar with accounting methods, and is willing to seek or accept assistance in the unfolding or disclosing of the real meaning of what is stated.

A review of the gross increases and decreases in the

various accounts gives a certain amount of information as to the general trend. Such statements customarily contrast two or more periods; they should also be charted graphically to show the range of fluctuations for a considerable period.

The reasons for many of these changes will be apparent at a glance to the officer in close touch with his operations, but it should be a part of his established routine to go over the records each month in detail with the members of his staff and an accounting officer, in order that complete knowledge may be had of the items that have gone into the transportation expense. Such a review will furnish an opportunity for an interchange of ideas between the two departments with a probable improvement in the work of each, and a greater appreciation of the effect of each operation and of each dollar of expenditure represented thereby.

To a peculiar extent the nature of the transportation function enables actual charges to be entered on a current monthly basis, and the important accounts represent, without explanation to the transportation officer, the costs of the things he has recently handled. Of a somewhat different character, however, are the accounts containing charges for various loss and damage items, and injuries to persons; also the so-called Joint Facility Accounts (390, 391, 412 and 413), in which the transportation expense is included, more or less with other point facility accounts, in other general expense accounts.

With respect to this system of accounting for joint facilities, it was first adopted by the Interstate Commerce Commission in 1907, and they expected that for all the railroads the debits would balance the credits, thus eliminating them from consideration, leaving the initial expense in the primary accounts of the owning lines. For various reasons, notably the ordinary "lap-overs," or failure to include bills in current accounts, this result has not been accomplished.

It is important that the terms and conditions under which facilities are operated jointly should be well known. Frequent investigations of these operations should be made in order to see that those being conducted have been prop-

erly authorized; that the terms of the contract or agreement are followed; that the arrangement has not been affected by changed conditions which would place the operations on a basis not considered equitable, and that the company's interest is fully protected.

In the various changes made in the manner of keeping the accounts by the Interstate Commerce Commission, the tendency seems generally to have been to relieve the expenses by charges to capital, possibly as a justification for reducing the rates. An interesting example of the odd way in which this has worked out is the change in the item Hire of Equipment from an "operating expense" to an item of Income Account. The effect is to distort the expenses as between the borrowing and the lending roads. Under M. C. B. rules the owner of a car is charged with practically all the expense of its maintenance except that which may result from accident or unfair usage. If road "A" is a heavy borrower of freight cars, its Maintenance of Equipment will be materially reduced, as the owner of the car will be paying directly, or indirectly, for repairs to the same, the expense for which is charged to its (the owner's) Maintenance of Equipment account, while the money received from road A as a rental is credited to its (the owning road's) Hire of Equipment account, road A at the time charging the money so paid to its Hire of Equipment account.

The transportation accounts may be made the basis of many profitable studies, especially of local conditions. From them may be drawn much information as to various classes of employees, their number, hours or days on duty, compensation, average rate of pay per hour or day compared with previous periods, the average cost per bill of lading issued and freight bill issued, and many like details. Studies of the efficiency of the several divisions of the organization may be made by associating with the appropriate physical units the costs as reflected in the accounts, while the units themselves may be segregated and examined.

When the operating revenues and the operating expenses

have been ascertained, the first step in the preparation of the income statement is stated in the following manner:

Railway Operating Revenues..............	$
Railway Operating Expenses..............	$
Net Revenue from Railway Operations......	$

It is hoped that the subtraction may always be made in the manner that was taught in our early school days, subtrahend from minuend, and that there will always be a considerable difference, because this figure is apt to be seriously affected by what follows.

140. General Accounts and Miscellaneous Matters.—Although the transportation officer has his most direct connection with those operations that are eventually reflected in the Operating Revenue and Operating Expense accounts, there are, nevertheless, certain items which are not includible in either of these, but are more or less interesting to the division officers on account of their indirect relation to their work and, further, their direct relation to the final status of the company's operations.

After the Net Revenue from Railway Operations has been ascertained, two items are deducted therefrom: Railway Tax Accruals and Uncollectible Railway Revenues. The latter is of relatively slight importance; the former is an item calling for very serious consideration. The so-called Property Taxes are generally verified and checked by the real estate agent. Beside these, however, there are various other federal and state taxes which are levied on capital stock, income, gross earnings, etc, in accordance with the provisions of a set of statutes amazingly indefinite, and the returns to be made for these call for the keenest scrutiny. The sums involved are enormous and are constantly increasing.

We now have a figure representing Railway Operating Income and, after considering the revenue from, expense of, and taxes on the so-called Miscellaneous Operations, reach what is termed Total Operating Income.

Then comes the consideration of items of what might be called a "general" nature:

1. Non-operating Income, which includes credits resulting from the hire of freight cars, interest on bank deposits and securities, and rents from locomotives, passenger cars and work equipment.
2. Deductions from Gross Income, which includes such items as debits resulting from hire of freight cars, rent for locomotives, passenger cars and work equipment, interest on funded debt, etc.

Consideration of all the items will then produce a figure representing "Net Income."

A "pen picture" of the company's operations is then ready to be set up in the following form:

I. OPERATING INCOME	
501. Railway operating revenues................	$
531. Railway operating expenses................	
Net revenue from railway operations.....	$______
532. Railway tax accruals.....................	
533. Uncollectible railway revenues.............	
Railway operating income................	$______
502. Revenues from miscellaneous operations.....	
534. Expenses of miscellaneous operations.......	
Net revenue from miscellaneous operations	$______
535. Taxes on miscellaneous operating property..	
Miscellaneous operating income..........	$______
Total operating income.............	$______
II. NON-OPERATIVE INCOME	
503. Hire of freight cars—Credit balance......	$______
504. Rent from locomotives....................	
505. Rent from passenger-train cars............	
506. Rent from floating equipment..............	
507. Rent from work equipment................	
508. Joint facility rent income................	
509. Income from lease of road................	
510. Miscellaneous rent income.................	
511. Miscellaneous non-operating physical property	
512. Separately operated properties—profit.....	
513. Dividend income	

514. Income from funded securities.............
515. Income from unfunded securities and accounts ....
516. Income from sinking and other reserve funds
517. Release of premiums on funded debt......
518. Contributions from other companies......
519. Miscellaneous income ....

Total non-operating income............. $______

Gross income (or loss)............. $______

III. Deductions From Gross Income

536. Hire of freight cars—Debit balance....... $
537. Rent for locomotives.....................
538. Rent for passenger-train cars..............
539. Rent for floating equipment...............
540. Rent for work equipment.................
541. Joint facility rents.......................
542. Rent for leased roads.....................
543. Miscellaneous rents ....
544. Miscellaneous tax accruals.................
545. Separately operated properties—Loss......
546. Interest on funded debt..................
547. Interest on unfunded debt................
548. Amortization of discount on funded debt....
549. Maintenance of investment organization....
550. Income transferred to other companies......
551. Miscellaneous income charges..............

Total deductions from gross income...... $______

Net income (or loss).............. $______

Even when this point has been reached, the accountant's work is by no means finished because he not only has to go further and account for the disposition of the net income, but he must also, after a consideration of the current transactions, recast his general balance sheet in order to show the carrier's assets, liabilities, profit and loss balance, etc. Although all this is very easily stated in a general way, few beside those familiar with the situation comprehend the scope of the problem.

My critical remarks with respect to the classifications issued by the Interstate Commerce Commission may be held to call for some constructive suggestion. I have prepared, as a suggestion, Fig. 31, which shows the number of accounts

FIG. 31.—CLASSIFICATION OF EXPENSE ACCOUNTS

Interstate Commerce Commission			English	
Name	Present	Suggested	Number	Name
Maintenance of Way and Structures	79	26	21	Maintenance of Way and Works.
Maintenance of Equipment	37	21	27	Maintenance and Renewal of Rolling Stock.
Transportation, Rail Line	50	33	12	Locomotive Running Expenses.
Transportation, Water Line	3	1		
Miscellaneous Operations	6	1	7	Expense of Collection and Delivery of Parcel and Goods.
Transportation for Investment Credit	1	1		
Traffic	9	12	16	Traffic.
General	12	9	10	General.
	197	104	93	

provided at present for the various classes of expenses, and those which I should think adequate. An outline of the English classification is inserted for comparative purposes.

Statistics

141. Statistics.—The ramifications of railroad operation are so widespread, the sources of possible wasteful expenditure, or possible economies, so numerous, that if a railroad is to be managed with a maximum of efficiency it is important that all information bearing on work done and cost of operation be drawn together and tabulated on uniform bases. Statistics cannot take the place of judgment, but they are most valuable aids to judgment; they serve as instruments to thought, to knowledge, and to work, and they should be compiled in the clearest, the briefest, and the most compact form. They should be as few as will cover the essential items and contain the details that explain the fluctuations which have taken place and where they occur. If sufficiently comprehensive, they will aid in the solution of problems and enable conclusions to be drawn and judgments matured. A common danger to be avoided is the careless assumption of data without testing their correctness, followed by an undue refinement in the calculations based thereon. Figures are no more than an aid in arriving at a conclusion; the practical guide is common sense. Statistics suffer from all the limitations of two-dimension space; arranged in serried lines and columns, having height and width, they lack the depth which alone gives that perspective in which relationship may be truly fixed. We have too often used financial statistics to the exclusion of physical statistics in analyzing operations. Fluctuating changes in rates of pay and prices of material invalidate comparisons, while constancy inheres in man hours, tons, ton miles, and engine and car miles. They also have the advantage of familiarity that comes from close personal association.

Statistics, too, should be kept so that information can be condensed from period to period on statements that will

enable comparison of cumulative periods. They should be brought together in folders. Many of the beneficial effects to be derived from their use are now lost through their being scattered over numerous sheets and through a failure to draw them together.

The use of diagrams is very helpful and they may be drawn to illustrate many statements, bringing, in a very direct way, material facts into prominent notice. Changes stand out and save much mental labor in carrying in mind a long series of figures. Memory will carry figures much better than it will carry graphs. The advantage of the latter is the sharp distinction of relativity. Care must be exercised in the choice of scales and illustrations for these diagrams. The use of colors is frequently advantageous to give emphasis to or direct attention to the significant facts.

Much of the benefit obtained from statistics is found in their display of the results of operation. Such evidence of results acts as an incentive to good work and excites a wholesome rivalry. Every one will wish to show improvement. It is equally desirable that bad working, from whatever cause, should come to light.

Statistics are not a cure-all, but a pointer or index to those who can read and interpret. They should not be used as a cause of action, but as an aid to the judgment in reaching a decision. The cost of producing the essential data is small. They may usually be assembled upon forms and reports currently made, and on an operating division will not employ the time of more than one clerk, while summarizing and working out the averages in the general office will not take over one hour per day. As a means of checking the shifting of blame from one department to another, and for reducing the friction between departments, statistical work is very valuable. The knowledge that the "head office" is in possession of all the essential facts with which to measure the efficiency of the work performed has a most stimulating influence, both upon the sluggard and upon the ambitious.

The staff of the general manager should contain two or three experienced men who thoroughly understand analysis and statistical work, and who, when his subordinate officers apply for help in assembling information, may be sent to their assistance.

Statistics wrongly used, or in such a way that the judgment formed thereon has no practical relation to the facts, are of very little use; when rightly used, they are most valuable.

I cannot help feeling that transportation officers generally are not doing enough "figuring." I am afraid they are not studying the statistics with a view to finding matters that are worthy of their attention, watching the results of their efforts, and finding out whether the facts justify their practice. The pad and pencil are much too valuable to fall into disuse.

It would be well if each transportation officer would systematically, and at fairly frequent intervals, say a half day each fortnight, review thoroughly some part of his operations over his entire territory. It will help if he confines his attention to one field of action, as, for example, the movement of cars, or the facilities used by trains in moving between terminals.

All officers should be occupied in considering the various solutions of these problems. It is detailed attention to minutiæ and consideration of trifles which spell success. It is only by the aid of complete statistics that the way can be pointed clearly to effective remedies.

"Figuring" will formulate many questions and answer some. When things are not going right, it is very desirable to know why they are not, and to give supporting reasons. Figure constantly on the little things and strengthen the judgment by testing it with the results shown. The more you figure, the more you will want to; the results are not only interesting, educating and satisfying, but profitable from the financial side; the thing to guard against is the adoption of an academic attitude, or falling into impractical habits.

There is much in the best practice of the literary art that may well be followed in the preparation of statistics. There is the same insistent demand for sincerity and truth. As Frank Norris says:

> It is not difficult to show that a man may be as accurate as the spectroscope and yet lie like a Chinese Diplomat. As for instance, let us suppose you have never seen a sheep, never heard of a sheep, don't know sheep from shavings. It devolves upon me to enlighten your ignorance. I go out into the field and select from the flock a black sheep, bring it before you, and, with the animal under your eyes, describe it in detail, faithfully, omitting nothing, I am painfully accurate. But you go away with the untrue conviction that all sheep are black! I have been accurate, but I have not been true.

There is a clear and sound distinction between literal facts and truth, so that one must remember the distinction and claim no more for accuracy than it deserves. To be accurate is not enough; to be true is the all-important business. Be, then, sincere, for sincere work is good work. Sincerity is the only enduring strength, it is a necessary condition of power.

But if truth goes before accuracy, the latter continues to be of prime importance. The facts cannot successfully be placed before us unless the compiler has gained clear insight into the thing upon which he reports. If you have any doubts about understanding a matter, try to draw it or to set it down in words. If you really know it you can faithfully describe it; the thought is organized by the effort at draughting or written expression.

The greatest simplicity insures the greatest accuracy. It is the details that give significance, but these must be shown in sharp outline, and interpreted as a part of our organized experience. Only then can we see what others do not or cannot see. If we carry on our thinking not by images but by signs, we expose ourselves to many chances of error and it is of the first importance that we guard against the fallacies of figures and of meaningless or misleading combinations and arrangements.

Compression is of prime importance—the science of omitting. So, too, is the expression of the image by two or more signs, where occasion indicates, since everything has two or more handles. We build up our methods upon habit, not upon rules, and a sign that appeals insistently to one habit of mind may leave another quite unmoved.

And, finally, the events should be stated in such sequence that the mind may not have to go backward and forward in order to connect them. The arrangement should be such that the significance of each may be understood as it comes, and in the order most convenient for the binding up of thought. Good statistics, like correct reasoning, are the ideal assemblage of objects or signs in their actual order of existence and succession. The purpose is by the written word; by the ordered figures; to make you hear; to make you feel; before all, to make you see. What we are to aim at is some side or point of circumstance or movement, and we must stand or fall by its significant simplicity, the very truth of its existence.

It is upon these statistics that we are to exercise our mental vision, our perception, inference, reasoning, and imagination. Our action is predicated upon the inferences we draw; the extension of the known to the unknown; the apparent to the unapparent. Here we must try to think the thing out to the end where all works worth while have their beginning.

Broadly speaking, the whole of the operating section of freight expenditure is covered by:

1. Costs at terminals
2. Car loading
3. Train loading
4. Engine mileage or hours

142. Terminal Freight Stations.—In comparing freight house handling the cost per ton and weight handled per man per hour may differ considerably at different places. We need, then, a knowledge of the layout and equipment

of each warehouse, checking, make-up of gangs, nature and number of consignments, and the number of packages and weight per package.

143. Car Loading.—In securing full carloads, the thorough training of expert loaders will repay the cost and trouble involved in their training. In every warehouse some man shows the greatest ability in loading, and his services should be utilized in going around from station to station to superintend for a time the loading at each.

It is impossible to overestimate the importance of full carloads. The maintenance cost of the car is practically independent of its load, so that a reduction in the number of cars is followed by reduced cost in almost the same ratio. Less demand is made upon the road locomotive, less yard handling is involved and less trackage needed, greatly reducing costs in congested areas. Care should be exercised to load traffic for connections in cars belonging to the connecting line, avoiding empty hauls and loss of use of one's own cars.

The American Railway Association has collected a large body of statistics on commodity loading, covering both L.C.L. freight and full carloads, showing the number of cars per month loaded by the reporting roads, average pounds per car, both total and by specified commodities, per cent of marked capacity utilized, etc. Taking out these data involves a very large amount of work, but occasional tests are of real value. A few should be made each month and every important commodity examined at least for one month in every two years.

The figures for the loading of cars should be collected so as to show in groups the commodities admitting loading to tonnage capacity and those that must be measured by the cubic capacity of the cars. They should reflect the L.C.L. business, the very light business, the medium light business, and the heavy tonnage business.

The loading of cars is greatly affected by commercial practices, as the selling of grain in 1000 bushel lots. A great waste of transportation resources is entailed because

these practices bear no relation to car capacity. An intelligent and systematic statistical record should be maintained as a basis for bringing these commercial customs in line with the economical use of transportation facilities.

When the 80,000 pound capacity box car came into use it was impossible to get full loads of grain. I had a careful inspection made of all the elevators on the road and the changes required in each. Though I made every effort to secure full loading, the commercial custom was too firmly fixed to be changed. There came at length a period of great car scarcity, and, being appealed to by one of the largest shippers, I offered him a full supply of cars conditioned on a full loading. The fact that he made the necessary changes in two days and maintained his relations with his customers indicates that, with exact information as to what is wanted and a fitting opportunity to take advantage of it, great advances may be secured.

Commodity statistics reflect the changes in each trade and make it possible to follow accurately the prosperity or depression of established fields of supply or reservoirs of traffic, the development of new fields, and diversions from one district to another, as well as their relative value to the company.

A considerable proportion of empty-car mileage is unavoidable, and runs for the country generally at about 30 per cent. It is important to know regularly how much this amounts to, with a view to keeping it as low as possible.

Much can be done by a capable car distributor, armed with adequate data at proper times. Here lies one of the greatest fields for economy, since the main object is to move the traffic as speedily and economically as conditions permit, in as few cars as possible, by securing the maximum loading. Curiously enough, it is at the busiest season of the year that the empty-car mileage will run the highest.

The skill with which the cars are handled to some degree regulates the number used, but the greatest influence is the seasonal demand and the number that must be provided to move the "peak of the load." The number out of service

because of "bad order" conditions should be carefully watched. The proportion should not much exceed 5 per cent. The control of cars is an important and difficult function. An excess of supply is not only costly, but congests the lines and terminals, and the public is likely to be less well-served than with a smaller supply handled to the best advantage.

It is one of the most discouraging things in the transportation business to realize during how small a percentage of the life of a car its wheels go round, and even then how considerable a proportion of this time it is running empty. The car averages, as we shall see, a loaded journey in 14.9 days, so that only 10 per cent of its life is spent in hauling a load. Now it is evident that a very small change in the time of the round trip, 14.9 days, will make a considerable difference in the number of cars required to handle the business of the country.

The part played in our transportation by the large car may be judged by a comparison with the English practice. On the North Eastern Railway the average carload in the mineral traffic was in 1904, 5.84 tons; in 1910, 7.93 tons; while the reported average carload of coal, which may be taken as a typical mineral, in the United States, was in March, 1920, 44.47 tons.

The things important to watch as a check on the service of the car are:

1. Ton miles per car mile. This reflects the loading of the car as distinct from its movement.
2. Car miles per car. This reflects the movement of the car as distinct from its loading, and the loaded and empty mileage should be separately shown.
3. Car days per loaded trip and per round trip; that is, from load to load.
4. Ton miles per car. This is the final and inclusive test of the service rendered by the car.

144. Train Loading.—A large part of the fluctuating cost of conducting transportation is due to train working, and statistics of trainloads are essential to economy. It is impos-

sible to exaggerate the importance of watching the trainload. Upon the number run depends the cost; the number run is dependent on the trainload; the greater the load the smaller the number of train miles. All transportation officers supervising train movements should have statistics of the daily operation, with weekly and monthly summaries, or summaries cumulative from day to day, or averages forwarded from day to day, as will best serve the purpose. Statistics should also show the part played by the use of pusher locomotives, to enable advantage to be taken of the general grade lines, or of assistant locomotives where they can be used without unduly increasing the length of the train. These should be closely watched, as great economy may result therefrom.

The test of ability in loading trains is the percentage of the possible maximum to that actually obtained, and as all trains are now loaded on a tonnage basis this percentage can be obtained for individual trains, or groups of trains, from a particular yard, or even from a particular district, as required. These figures of gross trainloads may also be used in watching coal consumption, a very heavy item of cost, and the percentage of freight to total load.

Ton miles, not the train miles, represent the work done by the carrier. The train mile is part of the cost of doing it. As J. J. Hill used to put it, "we manufacture train miles, we sell ton miles." To be prosperous, we must keep the cost of the train mile down and keep the price of the ton mile up. An analysis of the traffic is essential, since the loading is so much affected by differences in commodities. As a general principle, the cost is reduced by increased traffic density and by long haul, saving both in the proportion of terminal expense and in the number of cars and engines used, as well as in coal supplies and wages.

There should be weekly and monthly summaries indicating the actual work done by each individual train, and of all through trains starting with less than full load.

145. Engine Mileage or Engine Hours.—In watching locomotive costs, besides the mileage, the hourly use made of

the locomotive should be closely watched and used as a unit of performance. Too little use has been made in this country of these very valuable statistics. Many conditions operate to prevent a steady trainload being maintained month by month, making regular statistics of much greater value than those compiled for odd periods. It is much more easy to guard against overloading than underloading, and it is the latter that must be most carefully watched.

In 1903 Sir George Gibb, general manager of the North Eastern Railway of England, made an extensive examination of American operating practice and introduced on his road many changes looking to the use of statistics to secure economy of working. Among them the "ton miles per engine hour," a combination of the revenue work done (ton miles) and the working cost (engine hours), enabled the preparation of a reliable statement of the increased efficiency in train working which is fairly certain to follow an improvement in ton miles per engine hour.

Time occupied gives a broad, reliable, general result, but the different capacities of locomotives, the effect of length of runs, changes in rates of pay, and other things make actual costs and much other information desirable in the interests of economy.

A complete analysis of train-engine-hours for periods of not less than one week, at different times of the year, chosen so as to be as nearly as possible free from exceptional circumstances, is valuable.

In watching the yard work, engine hours are an excellent measure of cost for the locomotive and its average cost should be closely watched. The number of trains entering the yards, the number of cars (counted only once), the engine hours (road and switching locomotives separately), the number of cars entering per hour, loaded and empty, the wages paid, yard wages per car entering, and total cost per car entering, are all statistics of value. The mileage of yard engines is arbitrarily taken at 6 miles per hour. Automatic recording devices are in use that show the movement of locomotives and rate of speed, whether moving

backward or forward while at work. The train records should show minutes late on arrival or departure, time detained in yard, loading of train in number of cars and in gross tons, and the loading obtained in per cent of the locomotive rating. These results, made up daily, with summaries for weeks and months, and the principal average shown in diagram form, will aid the yardmaster in controlling and regulating the operation of the yard.

The significant things that should have daily attention are an analysis of the train sheet, the terminal handling of locomotives, the tonnages handled by each locomotive, and the yard car detention.

It is, in the last analysis, upon the movement of the rolling stock, upon the performance of locomotives and cars, that the efficiency of operation depends.

146. Probability.—Probability is a singularly fascinating subject and has attracted the consideration of many eminent mathematicians and logicians. We have an impressive branch of mathematics known as the "Calculus of Probabilities," but since at bottom judgment of equal initial probabilities depends upon a convention the conclusions reached are unconvincing.

While the definition of the mathematician is that probability is a numerical ratio, and while numerical probabilities undoubtedly exist, the logicians, of whom perhaps the latest is John Maynard Keynes, author of *Treatise on Probability,* prefer to conceive of probability as a relation between the events; that is, a relation between propositions. This line of reasoning denies the usual view of probability as based on statistical frequency. This perhaps may best be illustrated by such a case as Sopwell *v.* Bois. This was an action brought by a breeder of race horses to recover damages for breach of a contract. The contract was that Cylene, a race horse, owned by the defendant, should, in the season of the year 1909 serve one of the plaintiff's brood mares. In the summer of 1908 the defendant, without the consent of the plaintiff, sold Cylene for £30,000 to go to South America. The plaintiff claimed a sum equal to the average

profit he had made through having a mare served by Cylene during the past four years. During those four years he had had four colts which he had sold for £3300. Upon that basis his loss came to 700 guineas. Here a probability was certainly involved but its relation was like the relation of similarity; it might be greater or less. The judge decided the case not on the relation of numbers but on the relation of events. He held the plaintiff's case to be based, for instance, upon assumption that Cylene would be alive and well at the time of the intended service; that the mare sent would not be barren; that she would not slip her foal; that the foal would be born alive and healthy. There was a breach of the contract, damages were due, but he could not estimate these chances and so he could not estimate the damages, and found himself unable to award more than nominal damages.

Mr. Keynes takes exception to the claims of the mathematician, that when the events are natural events, such as are dealt with in statistics, their assumption is not likely to be a true one. He discusses the philosophic aspects of "induction" and "analogy"; distinguishes between systems possessing a finite and those possessing an infinite amount of independent variety and holds that an inductive argument may lead to probable knowledge if the facts or propositions with which the arguments are concerned belong to a finite system.

The use of statistics presents many great and unusual difficulties. One must be sure not only that they are accurate, but that they are truthful; be sufficiently familiar with the location, plant, personnel, etc., to recognize the influence of third factors, and know whether the probability which they suggest is a numerical ratio or a relation between events.

The longer one uses them the more one comes to feel that at best they are but an aid to judgment, and the more one is aghast at the assurance of the bureaucrat who may be distant a thousand miles from the scene of action and have so little familiarity with the actual workings as not to be able for the life of him to tell you the difference between a

puzzle switch and a flying switch or between demurrage and democracy, but who does not hesitate to issue positive orders upon the conclusions he draws from his statistics.

At once useful and dangerous, statistics are safe instruments only when handled with caution and with firmness. Just as the Sphinx Atropis, gaining entrance to the hive and imitating, it is said, the trumpetlike cry of the Queen Bee, as by a magic command terrifies and throws into a kind of stupor all bees in the hive; so statistics, like glowing phrases kept whirling in our heads, may stupefy and blind us to the realities of things.

PART V

MOVEMENT OF CARS

In the freight car is moved nearly all the food we eat; the clothing we wear; the materials for our homes and their furnishing; the fuel used in the provision of heat, light and power. In it, all substances of use to man are transported from place to place for transformation through all of the stages and processes that make them of service. There is, perhaps, no other vehicle which so adequately ministers to the multitudinous wants of each and every one.—McPherson.

PART V

MOVEMENT OF CARS

147. Proportions of the Time that Cars Are in Use by the Railroads and by the Traders.—The freight car is one of the prime units of freight transportation, and the success of the railroad operation is very largely dependent upon the quantity in which it is supplied and the use made of it. It must be kept constantly in mind that also for the individual trader the supply and movement are of the utmost importance. For the railroads the earnings which these cars bring in are the largest part of their profitable business. Upon these earnings they depend for their solvency and growth. That the average gross earnings of a car in the year 1919 were only $3.93 per day is a matter of disappointment and disquiet. It is therefore of the first importance to see what aids and what obstructs the movement of these cars.

Through thoughtless statements put out as matured judgments by some assumed to speak with authority; by the adroit attacks of vote solicitors seeking personal preferment, and by the swarm of haters of private property; the public has at times been excited to the verge of hysteria over the alleged inadequate provision of freight cars to handle its rapidly growing business.

Between the time when a freight car is delivered by the builder and the time when it is dismantled, it makes many trips, of which the following is the simplest:

It is shifted into place to be loaded.
It is drilled into a train.
It is moved to destination.
It is unloaded and is then ready for another trip.

This is typical of the movement of a freight car from one station to another on the same division of the same railroad. If moved from a station on one division to a station on another division of that railroad, it will probably be

drilled from the local train on one division through a division yard into a local train on the other division. Freight cars are moved, however, not only over one or more divisions of the same railway, but also over the lines of two or more different railways. In the passage from the main line of one to the main line of another railway, a freight car goes through terminal interchange yards, or tracks, and is interchanged by being drilled from the train of one into the train of the other railway.

The movement of by far the greater portion of the freight traffic of the United States is from centers where freight originates in great quantities, from mines, mills, grain elevators, slaughter and packing houses, places where the products of orchards and truck farms are collected, and from the great wholesale warehouses. Such movement is in carload lots to the great distributing centers where the cars are unloaded, and these movements entail a large percentage of empty mileage in adapting the supply of cars to the demand. At the great originating centers and the great distributing centers are tracks, variously designated as delivery tracks, private sidings, etc., upon which empty cars are shifted to be loaded, and loaded cars are shifted to be unloaded. The loading and unloading of carloads is performed by the shippers and the consignees.

Consignees are allowed to retain a car free of charge for 48, and in other cases for 72, hours, prior to unloading. Another practice is to allow the shippers of large quantities of merchandise to make shipments before they have found purchasers, and to hold such shipments on storage tracks until sales have been made, when they are reconsigned to destination. The vice of this is that it is at its worst when cars are in greatest demand. A similar waste of car capacity is produced by light loading.

The repairs made to the freight cars by the railroads keep every car out of service a portion of the time. So, also, cars provided to care for the full flow of traffic must be stored when traffic declines in volume.

Taking the course of the freight car in this carload service, it will be seen that it is in the hands of the public,

that is, the shippers and consignees, part of the time, and in the hands of the railroads part of the time. In order to determine what steps should be taken to obtain greater service from freight cars in the actual transportation of freight, it is necessary to ascertain what are the causes of the present admittedly deficient utilization; that is, to ascertain what are the causes which delay the movement of freight cars when they are in the hands of the public, and what are the causes of delay when they are in the hands of the railroads.

It goes without saying that the time occupied in the round of switching for load, moving to the assembling yard, drilling into train, movement in train, passage through divisional terminal yards and interchange tracks, movement in train, switching for unloading, is not the same for each round of each car, nor for each car during a given time. But from an average obtained from the trips of all the cars for a considerable period may be presented the typical trip of a freight car. By confining our attention to such a trip and to the 24 hours of the day, and dividing and subdividing these in order to minimize possible errors, data may be obtained that are true for the United States as a whole.

The processes through which these averages and this approximation have been determined are as set forth in the appended tables and notes. We are here concerned with the results of these processes.

The average trip of a freight car occupies 14.9 days. This is made up as follows:

Time spent in:	*Days*
Road movement	1.49
Delay in road movement	.15
Movement to and delay on interchange tracks	2.48
Movement through intermediate yards	1.55
Movement to and delay on storage tracks	.75
Movement to and delay on repair tracks	1.34
Movement for and loading and unloading	5.74
Reconsigning, hold "to order," etc	.50
Delay because of Sundays and holidays	.90
Total	14.90

This table, which I prepared some years ago, shows that in the average trip the traders have the car in their possession $36^1/_3$ per cent of the time, and that the railroads have the car in their possession $63^2/_3$ per cent of the time.

The shifting and interchange movements consume on the average 10.1 hours out of the 24 hours of the day, or 66.4 per cent of the time that the freight car is in the possession of the railroads.

148. Distribution of the Time of a Typical Freight Car Movement.—The references in the following table are to items in the explanatory analysis following:

Distribution of the Time of a Typical Freight Car Movement

Items	Days per Trip	Hours per Day	Per Cent of Trip or Day	Reference Numbers
Normal road movement—357 miles at 10 miles per hour	1.49	2.4	10.0	1, 8
Road delays—reflected in overtime, 10 per cent	0.15	0.2	1.0	1, 8
Movement through intermediate yards—3.57 per trip	1.55	2.5	10.4	10*a*, 11*a*
Interchanges between railroads—1.81 per trip	2.48	4.0	16.7	2, 10*b*, 11*b*
Movement between terminal yard and loading and unloading tracks—4 per trip	1.74	2.7	11.6	
Surplus cars and their movement between yard and storage tracks	0.75	1.2	5.0	3, 10*c*, 11*c*
Repairing cars and their movement between yard and repair tracks	1.34	2.2	9.0	4, 10*d*, 11*d*
Total responsibility of railroad	9.50	15.2	63.7	
Loading and unloading	4.00	6.5	26.8	5
Delay because of the traders' practice of "bill to order," "reconsignment," "plant facility use," etc.	0.50	0.8	3.4	6
Delay due to observance of 52 Sundays and 10 holidays per year	0.90	1.5	6.1	7
Total responsibility of shipper	5.40	8.8	36.3	
Total time	14.90	24.0	100.0	

There is a considerable number of cars absorbed in the movement of company material, especially fuel coal, averag-

ing over the year 44,597 daily. These are involved in a delay of from three to five days each, but as against this there is a very prompt unloading of cars at the companies' freight depots, and both items have been canceled out, the error, if any, favoring the traders.

Analysis and Discussion of the Table

These figures are computed from the following sources and in the following manner:

1. The Interstate Commerce Commission figures for 1910 are as follows:
   (*a*) Miles per freight car per day slightly less than 24.
   (*b*) Average haul per ton of freight, which we may assume is the average load haul per freight car, 249.68 miles; the percentage of empty to loaded mileage is 43, so that each car makes an empty trip of 107.36 miles, or a total of 357 miles loaded and empty per trip.
   (*c*) This at 24 miles per car per day would occupy per trip 14.9 days.
2. The average loaded haul on one railroad is given by the Interstate Commerce Commission as 138.31 miles; the average loaded haul on all railroads is given as 249.68 miles. This equals 1.81 times the haul on one railroad, or there are 1.81 interchanges between railroads in the typical haul. We may assume that the average delay on the interchange track is one-half day per interchange, making a total of 0.90 day delay on interchange track per trip.

The American Railway Association bulletins for 1910 show:

3. Average number of surplus cars, 92,048, or 4.3 per cent of the total freight equipment. The total time lost on account of surplus cars, therefore, equals 14.9 days multiplied by 4.3 per cent, or 0.64 day per car per trip.
4. Cars in shops 6.28 per cent. The average delay to cars in shop per trip is therefore equal to 14.9 days multiplied by 6.28 per cent, or 0.93 day per car per trip.
5. Based on the study of old Eastern Demurrage Bureau figures and the movement of cars under different conditions, it seems fair to assume a delay in loading and a delay in unloading of 2 days each or 4 days total per car per trip.
6. Many cars are held for reconsignment, switching orders, trans-

fers, etc., some more than once, and it would seem fair to allow a total delay for this reason, of 0.5 day per car per trip.

7. The business of railway transportation is conducted on the basis of 24 hours per day, 365 days per year. The commercial business, however, is conducted on the basis of 10 and 8 or less hours per day and concentrates the movement of many commodities into limited seasonal periods. There is a further loss of 52 Sundays and 10 holidays per year. The delay of at least 20 per cent, or 0.90 day per car per trip, due to the observance of Sundays and holidays, has been charged against the shipper, while the delays due to the seasonal and hourly variations in the shippers' business have been charged against the railroads.
8. Assuming the normal road movement as 10 miles per hour, for the 357 miles of the average loaded and empty movements of a car per trip, 35.7 hours, equal to 1.49 days per car per trip, are required.
9. General experience, reinforced by the testimony before the 1912 Engineers' Arbitration Committee, indicated the average road delay to be about 10 per cent or 3.57 hours, or 0.15 days per car per trip.
10. Summarizing, we have the following time consumption:

	Days
Road movement	1.49
Road movement delay	0.15
Delay on interchange tracks	0.90
Delay on storage track	0.64
Delay on repair track	0.93
Loading and unloading	4.00
Reconsigning, bill-to-order, etc	0.50
Sundays and holidays	0.90
Total	9.51

Subtracting this from the average trip of 14.9 days leaves 5.39 days to be accounted for.

11. These 5.39 days are consumed in the execution of the following movements:
    (*a*) Movement through intermediate yards. Assuming terminals to be 100 miles apart, the normal car movement involves passing through 3.57 intermediate yards, or 3.57 movements per car per trip.
    (*b*) Movement for interchange between railroads. Interchange involves 2 movements, delivery to the interchange track and removal from the interchange track. As already stated, the Interstate Commerce Commission figures indicate 1.81 interchanges, or 3.62 movements per trip.

(*c*) Movement forced by necessity to store cars. The effort to provide sufficient cars for the movement during the rush season results in a provision of equipment that is idle to the extent of 92,048 cars, or 4.3 per cent of the total equipment as of the entire year. If this idle time is apportioned to the 14.9 days of the average trip made by a car, it will amount to 0.64 day for that trip. These cars, however, are not individually designated and set aside during the period of non-use, but this non-use is distributed over the entire equipment in its normal use and movement. It is, of course, impossible to trace this influence definitely, but there are many reasons to indicate that as from time to time cars are taken out of service for storage on account of absence of demand for their use, the average period of detention is 5 days.

If the time lost in storage per trip is 0.64 day, and the length of time of the storage when made is 5 days, then dividing the former by the latter we obtain 12.8 per cent of a car stored for each car's trip, and as the storage involves two movements it amounts to 0.26 movement per trip.

(*d*) Movement to repair tracks. The necessity for taking bad order cars out of service for the purpose of repairing them involves an average loss for effective service of 6.28 per cent of the total equipment as of the entire year. If this lost time is apportioned to the 14.9 days of the average trip made by a car, it will amount to 0.936 day for that trip. This loss of usefulness is distributed over the entire equipment in its normal use in movement. Such figures as are available indicate that, as from time to time cars are taken out of service for repairs, the average period of detention on the repair track is 2 days.

If the time lost on the repair track per trip is 0.936 day and the length of time on the repair tracks per repair is 2 days, then, dividing the former by the latter, we obtain 4.68 per cent of a car placed on repair track for each car's trip, and if this placing and removal involves 2 movements it amounts to 0.93 movement per trip.

(*e*) Movement to secure loading and unloading. Placing and removal of car for loading and unloading involves 4 movements per trip.

12. Totaling these figures we obtain 12.28 switching movements per trip, occupying 5.39 days, or an average of 0.43 day per

switching movement. Applying these figures, we obtain the following delay per car per trip for switching movements:
(*a*) Through intermediate yards 3.57 movements, 1.55 days.
(*b*) Interchange, 3.62 movements, 1.58 days.
(*c*) Storage, 0.26 movement, 0.11 day.
(*d*) Repairs, 0.93 movement, 0.41 day.
(*e*) Loading and unloading, 4 movements, 1.74 days.
Total, 5.39 days.

Adding these figures to those of paragraph 9, the data of the first table are obtained.

Adhering closely to the above method of analysis, the Bureau of Railway Economics made a review of the average car movement for the year 1918 and determined the amount and distribution of time, which I have applied to the revenue freight cars owned by all railroads on March 1, 1920, as follows:

REVIEW OF AVERAGE CAR MOVEMENT, 1918

Item	Days per Trip	Per Cent	Number of Cars
Normal road movement	1.97	10.91	261,181
Road delays	0.68	3.77	233,411
Movement through intermediate yards	1.76	9.75	80,916
Interchanges between railroads	0.61	3.38	232,214
Movement between terminal yards and loading and unloading tracks	1.75	9.70	90,253
Abnormal Delays			
Connections unable to accept	1.21	6.70	160,395
Account embargoes	0.40	2.22	53,146
Other causes as reflected in accumulations	3.28	18.17	434,983
Total responsibility of railroads	11.66	64.60	1,746,499
Loading and unloading	4.00	22.16	530,502
Delay due to "billed-to-order," reconsignment, etc	0.25	1.38	33,037
Delay due to Sundays and holidays	0.87	4.82	115,389
Abnormal Delays			
Overtime holding, as reflected by demurrage	1.00	5.54	132,626
Consignee's inability to accept	0.05	0.28	6,703
Further observance of Sundays and holidays, due to other abnormal delays	0.22	1.22	29,206
Total responsibility of public	6.39	35.40	847,463
Total	18.05	100.00	2,393,963

149. The Stock of Cars in the Country and the Use Made of Them.—Freight equipment is not exclusively a railway interest, nor is its maximum use solely important to the transportation companies. Every shipper and every consignee is proportionately concerned in the advantages, the gain in money, time, and convenience, that would result from betterment in existing conditions. Every shipper and every consignee is proportionately responsible for the delays and consequent waste of time and money now occurring, and is proportionately able to contribute to better conditions. If car movement can be expedited and greater loading secured, car shortage will be reduced, and better service and more mileage will be furnished without increased charges for capital and for maintenance of equipment and permanent way, and the result will be a relief that will be felt to the remotest recesses of the public interest.

A car in continuous motion might be moved 250 miles in a day. Its average daily movement is nearer 25 miles.

It is apparent that the actual speed of the trains has very little effect in determining actual miles per car per day.

Likewise must we dismiss the tonnage loading of trains as being a material factor.

The conclusion is inevitable that the mileage made by freight cars, as averaged on a daily basis, is affected chiefly by the length of time consumed in terminal handling and the time consumed by the trader in loading and unloading freight.

So much complaint was made about car supply in 1905 and 1906, that, at the beginning of 1907, the railroads collected and tabulated information for the whole country showing the number of cars ordered for loading, the number of cars supplied in filling orders, and the number of cars in equipment stock in excess or deficiency of the cars ordered. The publication of these statistics was abandoned when the government took over the control of the railroads, but the attached statements and charts (Figures 34 and 37) show the situation. The huge blocks indicating equipment serving no useful purpose are most impressive. It must be kept in mind

that these figures are based on the assumption that the orders placed by shippers for cars for loading represent their actual needs. It would seem likely, therefore, that the zero line should be placed considerably lower, especially at times when there is an active movement.

During the years 1917, 1918, and 1919, a very determined effort was made to secure better loading of freight cars and, under the spur of patriotic impulse and the recognition of the benefit to the common need of common exertion, the load per car was substantially increased; for 1918 to 65.56 per cent of capacity. As already stated, the railroads secured their highest average miles per car per day in 1916, 26.9 miles.

In Figures 35 and 37 is shown the number of cars required to handle the business offered over a period of years under this increased mileage and increased loading. In Figures 38 and 39 is reflected the maximum business that could have been handled with the available equipment, if the idle cars had been used, if the loading had been 65.56 per cent of capacity (as for 1918), and the car mileage of 26.9 miles per car per day (as for 1916) had been attained.

In 1918 the tons carried one mile were more than 398,000,000,000, with an average miles per car per day of 24.9, but the loading in this year reached its maximum of 65.56 per cent with an average tons per car of 26.88. If, however, the mileage per car per day had been speeded up to 26.9 (as in 1916), the available equipment would, under like operating conditions, have handled more than 433,000,000,000 tons, or an increase of 8.74 per cent.

In 1919 the miles per car per day decreased to 23.1, but the loading in that year reached 64.66 per cent of capacity. The total tons carried one mile amounted to more than 362,000,000,000. Had the cars been loaded up to 65.56 per cent, as in 1918, and speeded up to 26.9, the mileage of 1916, the available equipment under similar operating conditions would have handled more than 450,000,000,000 tons, an additional tonnage of 88,000,000,000, or 24.3 per cent. However, it should be recalled that during the early part of 1919

there was a surplus of cars, reaching a peak of 500,000 with no shortage developing until the latter part of the year.

All statistics regarding car surpluses and car loading are based upon the assumption that the requisitions of the shippers are in exact accordance with their requirements. This is far from the fact in times of business activity. At junction points, or points served by more than one railroad, it is frequently found that shippers place duplicate orders with two or more roads to insure an ample car supply, while at other points they, for the same reason, exaggerate their requirements. I have in mind the case of a mine which in the fall of 1921 placed an order for 15 low-side and 35 high-side cars daily. For the period investigated, this would amount to 120 low-side and 280 high-side cars, a total of 400 cars, which were tendered, but only 73 low-side and 93 high-side cars, or a total of 166 cars, were actually loaded, or·42 per cent of the order placed. This is not to be taken as an isolated example, but as a matter of common experience.

The opportunities for improvement in car use and the consequent decrease in the number in stock may be roundly summarized in the following simple figures: (*a*) an increase of one ton in the average lading for each car would be the equivalent of making available 80,000 more cars, and (*b*) an increase of one mile in the average mileage made per car per day would be the equivalent of making available 100,000 more cars.

The figures also show that the number of tons handled one mile in the years 1917 and 1918 were in excess of 394,-000,000,000, or more than 100,000,000,000 above any one of the years 1906 to 1915, inclusive, with the exception of the year 1913, which is exceeded by approximately 93,000,000,000. The years 1917 and 1918, covering the war period, when production was speeded up to the maximum, may reasonably be said to reflect the maximum production and the maximum that may be expected for the next two or three years. But if, happily, these tonnages are materially exceeded, and the maximum mileage and maximum loading are secured, it appears that the present freight equipment can handle a ton-

nage over 13 per cent in excess of the tonnage of 1917 and 1918.

It should be borne in mind, also, that during the three-year war period between 1917 and 1919 our exports reached their maximum. In 1916 the ratio of imports to exports was over 50 per cent, while during the three-year period 1917 to 1919 the ratio of imports to exports was 45.4 per cent. This clearly illustrates that because of our exports a larger percentage of business handled in connection with foreign trade was destined to seaboard during the period mentioned than obtained in the years previous, thus producing a loaded movement largely one way and a material increase in empty car mileage which would not have resulted in normal periods of more evenly balanced traffic. This was a contributing factor in causing an empty car movement during this three-year period of over 31 per cent of the freight car mileage as compared with 29.8 per cent obtaining in the year 1916.

For some ten years I compiled such information as I could collect from the annual reports of lines over 500 miles in length as to freight cars and the use made of them, and the *Railroad Gazette* published these tables annually, usually in the month of May. Since the first was prepared the Interstate Commerce Commission has classified the roads, placing in Class I roads earning gross over $1,000,000 annually. The Bureau of Railway Economics has courteously furnished me with the information necessary for the inclusion of all roads in Class I for the years 1905 to 1919, inclusive, and Figure 32, which is a summary of the information, will well repay careful study.

Figure 33 is an abstract of the above-mentioned table, showing the main line mileage, freight equipment, its increase or decrease, and the use made of the same for the years shown, on all Class I roads in the country. From this it will be seen that there has been very little change in the number of cars per 1,000 ton miles moved since 1906, and that the average number of cars added annually to the equipment stock during the period was 42,060. This, how-

ever, does not accurately reflect the effect of the car supply on the movement of traffic since the average capacity of the cars increased from 32 tons in 1906 to 41 tons in 1918, or 28 per cent. It is true that many more cars were purchased annually than is indicated by the additions to equipment, but many of them were purchased in replacement of cars considered obsolete because of light capacity or for other reasons. This special demand for new equipment is now largely supplied since there were on March 1, 1920, only 41,896 cars under 60,000 lbs. capacity and 551,942 cars from and including 60,000 lbs. but under 80,000 lbs. capacity on all Class I lines in the country.

Consideration must also be given to the effect upon the service of the cars of changes in construction from the old wooden-sill car, supported by a hog-chain truss, to the present practice of steel underframes, which permits of loading to 10 per cent in excess of marked capacity. If to the marked capacity of the equipment of 1919 (more than 98,000,000 tons) this 10 per cent be added, the capacity would be more than 108,000,000 tons, as contrasted with 59,000,000 tons in 1906, or an increase of over 80 per cent. The ton mileage in 1906 was more than 215,000,000,000; the increase in ton miles in 1918 as compared with this figure was more than 138,000,000,000, or 53.52 per cent, while the service capacity of the cars had increased in the same period by 83 per cent. The increase in car capacity offered was evidently nearly 30 per cent over the increased demand.

Owing to the seasonal demands made upon equipment (see Figure 40), the peak of the load is in the months of October and November and the valley in the months of May, June, and July, the difference in the demands of the heavy and light days for the average of the years 1907–1918, inclusive, being 47,576 cars. One of the questions always to be borne in mind is the extent to which this should be taken care of by the railroads, or by the traders through grain elevators, cotton platforms, and other reservoirs for storage. It is not to the interest of the country that equipment for which use can be found only for a period of perhaps six

FIG. 32.—RECAPITULATION CLASS I ROADS—

MILES OPERATED—SINGLE TRACK, FREIGHT EQUIPMENT IN SERVICE, AVER
PER MILE OF ROAD; PER 1000 FREIGHT-CAR MILES; PER 1000 REV

(*For the years 1905*

Item	Year Ended—						
	1905	1906	1907	1908	1909	1910	1911
Miles operated — single track:							
Eastern District	53,358.89	54,984.90	55,572.44	56,079.20	56,236.03	56,512.56	56,856.57
Southern District	36,680.37	37,445.64	38,502.95	39,303.50	39,738.45	40,315.09	40,580.06
Western District	104,687.32	108,367.81	110,315.38	112,725.45	115,406.41	119,591.22	121,902.45
United States	194,726.58	200,798.35	204,390.77	208,108.15	211,380.89	216,418.87	219,369.08
Freight equipment in service (excluding caboose):							
Eastern District	835,652	893,038	956,029	1,019,993	1,004,416	1,029,705	1,052,272
Southern District	259,541	285,370	331,212	349,627	349,218	354,033	366,653
Western District	563,975	591,259	629,161	658,678	656,600	685,493	704,911
United States	1,659,168	1,769,667	1,916,402	2,028,298	2,010,234	2,069,231	2,123,836
Average length of haul:							
Eastern District	113.79	125.23	125.98	132.67	131.71	128.77	130.43
Southern District	189.41	190.08	187.20	186.59	189.38	189.02	188.67
Western District	189.96	192.74	204.88	202.29	193.65	187.78	188.63
United States	148.53	152.20	153.13	157.45	155.74	152.06	153.30
Rate per ton-mile (dollars):							
Eastern District	.00661	.00648	.00650	.00641	.00641	.00637	.00638
Southern District	.00731	.00714	.00729	.00723	.00712	.00693	.00699
Western District	.00925	.00903	.00897	.00914	.00938	.00935	.00944
United States	.00756	.00741	.00745	.00744	.00751	.00743	.00746
Freight train cars per mile of road:							
Eastern District	15.7	16.2	17.2	18.2	17.9	18.2	18.5
Southern District	7.1	7.6	8.6	8.9	8.8	8.8	9.0
Western District	5.4	5.5	5.7	5.8	5.7	5.7	5.8
United States	8.5	8.8	9.4	9.7	9.5	9.6	9.7
Freight train cars per 1000 freight car-miles:							
Eastern District	.119	.114	.121	.132	.136	.122	.121
Southern District	.109	.110	.126	.141	.134	.123	.121
Western District	.105	.100	.101	.113	.110	.104	.107
United States	.112	.108	.114	.127	.126	.115	.116
Freight train cars per 1000 revenue ton-miles:							
Eastern District	.0087	.0081	.0079	.0091	.0091	.0080	.0082
Southern District	.0094	.0089	.0097	.0109	.0104	.0090	.0090
Western District	.0096	.0085	.0080	.0092	.0091	.0084	.0089
United States	.0091	.0083	.0082	.0094	.0093	.0083	.0085
Freight train cars per 1000 dollars of freight earnings:							
Eastern District	1.318	1.246	1.212	1.427	1.424	1.255	1.285
Southern District	1.282	1.245	1.326	1.512	1.462	1.293	1.290
Western District	1.040	0.945	0.890	1.008	0.970	0.896	0.939
United States	1.203	1.126	1.098	1.268	1.240	1.113	1.145

Eastern, Southern and Western Districts

AGE LENGTH OF HAUL, RATE PER TON-MILE, AND FREIGHT TRAIN CARS ENUE TON-MILES; AND PER 1000 DOLLARS OF FREIGHT EARNINGS

to 1919, inclusive)

June 30					Year Ended—Dec. 31			
1912	1913	1914	1915	1916	1916	1917	1918	1919
57,299.70	57,614.40	57,844.14	57,911.45	58,277.20	58,448.51	58,802.60	58,770.04	58,730.35
41,574.07	41,656.07	41,874.65	42,182.28	42,750.17	42,550.43	42,652.86	42,611.97	42,807.27
124,181.00	126,181.87	128,034.58	129,054.17	129,440.95	129,863.15	130,364.01	129,921.35	129,847.38
223,054.77	225,452.34	227,753.37	229,147.90	230,468.32	230,862.09	231,819.47	231,303.36	231,385.00
1,061,480	1,086,997	1,095,651	1,089,286	1,086,745	1,094,151	1,116,633	1,110,876	1,119,759
370,708	372,957	384,006	389,143	375,975	382,788	396,478	400,731	399,539
715,637	752,099	786,133	782,725	773,148	775,206	792,105	808,775	794,003
2,147,825	2,212,053	2,265,792	2,261,154	2,235,868	2,252,145	2,305,216	2,320,382	2,304,301
129.87	131.39	130.59	136.92	136.22	140.56	146.76	147.70	150.59
191.80	193.38	193.89	203.40	207.34	207.20	209.71	212.40	209.27
189.88	192.85	191.66	198.39	202.64	205.11	214.95	221.00	225.57
153.64	155.42	155.48	163.05	163.73	167.77	175.41	178.07	181.01
.00638	.00625	.00632	.00647	.00648	.00647	.00663	.00811	.00911
.00690	.00680	.00672	.00640	.00620	.00622	.00636	.00754	.00872
.00915	.00887	.00890	.00881	.00844	.00837	.00891	.00944	.01100
.00735	.00719	.00725	.00724	.00708	.00708	.00738	.00848	.00971
18.5	18.9	18.9	18.8	18.6	18.7	19.0	18.9	18.9
8.9	9.0	9.2	9.2	8.8	9.0	9.3	9.4	9.3
5.8	6.0	6.1	6.1	6.0	6.0	6.1	6.2	6.1
9.6	9.8	9.9	9.9	9.7	9.8	9.9	10.0	10.0
.121	.115	.120	.123	.108	.107	.114	.116	.127
.119	.114	.113	.117	.101	.101	.101	.080	.111
.108	.104	.109	.109	.096	.091	.090	.095	.095
.116	.111	.115	.117	.102	.100	.102	.101	.111
.0080	.0071	.0077	.0082	.0065	.0062	.0060	.0058	.0066
.0086	.0079	.0079	.0082	.0064	.0062	.0058	.0056	.0063
.0087	.0079	.0085	.0086	.0069	.0063	.0058	.0057	.0062
.0083	.0075	.0080	.0083	.0066	.0063	.0059	.0058	.0064
1.254	1.142	1.221	1.257	1.004	0.965	0.903	0.719	0.721
1.250	1.161	1.160	1.285	1.040	0.999	0.913	0.738	0.718
0.949	0.885	0.959	0.979	0.820	0.754	0.647	0.606	0.559
1.132	1.042	1.108	1.148	0.937	0.885	0.797	0.678	0.655

FIG. 33.—COMPARATIVE SUMMARY OF FREIGHT CARS IN SERVICE ON RAILROADS OF THE UNITED STATES

						Freight Cars					
Year	Miles	Freight Equipment	Increase Over Previous Year	Decrease Under Previous Year	Per Cent of Change	Per Mile of Road	Per 1000 Freight Car Miles	Per 1000 Revenue Ton Miles	Per $1000 Freight Earnings	Average Length of Haul	Rate per Ton Mile ($)
1900	139,289	1,107,718				7.9	.111	.0112	1.36	168.89	.00857
1905	194,727	1,659,168	*551,450		4.98	8.5	.112	.0091	1.203	148.53	.00756
1906	200,798	1,769,667	110,499		6.24	8.8	.108	.0083	1.126	152.20	.00741
1907	204,391	1,916,402	159,797		9.10	9.4	.114	.0082	1.098	153.13	.00745
1908	208,108	2,028,298	111,896		5.52	9.7	.127	.0094	1.268	157.45	.00744
1909	211,381	2,010,234		18,064	0.89	9.5	.126	.0093	1.240	155.74	.00751
1910	216,419	2,069,231	59,232		2.95	9.6	.115	.0083	1.113	152.06	.00743
1911	219,369	2,123,836	54,605		2.64	9.7	.116	.0085	1.145	153.30	.00746
1912	223,055	2,147,825	23,889		1.13	9.6	.116	.0083	1.132	153.64	.00735
1913	225,452	2,212,053	64,228		2.99	9.8	.111	.0075	1.042	155.42	.00719
1914	227,753	2,265,792	53,739		2.42	9.9	.115	.0080	1.108	155.48	.00725
1915	229,148	2,261,154		4,638	0.19	9.9	.117	.0083	1.148	163.05	.00724
1916	230,862	2,252,145		9,009	0.40	9.8	.100	.0063	0.885	167.77	.00708
1917	231,819	2,305,216	53,071		2.35	9.9	.102	.0059	0.797	175.41	.00738
1918	231,303	2,320,382	15,166		0.66	10.0	.101	.0058	0.678	178.07	.00848
1919	231,385	2,304,301		16,081	0.69	10.0	.111	.0064	0.655	181.01	.00971

* Increase over 1900.

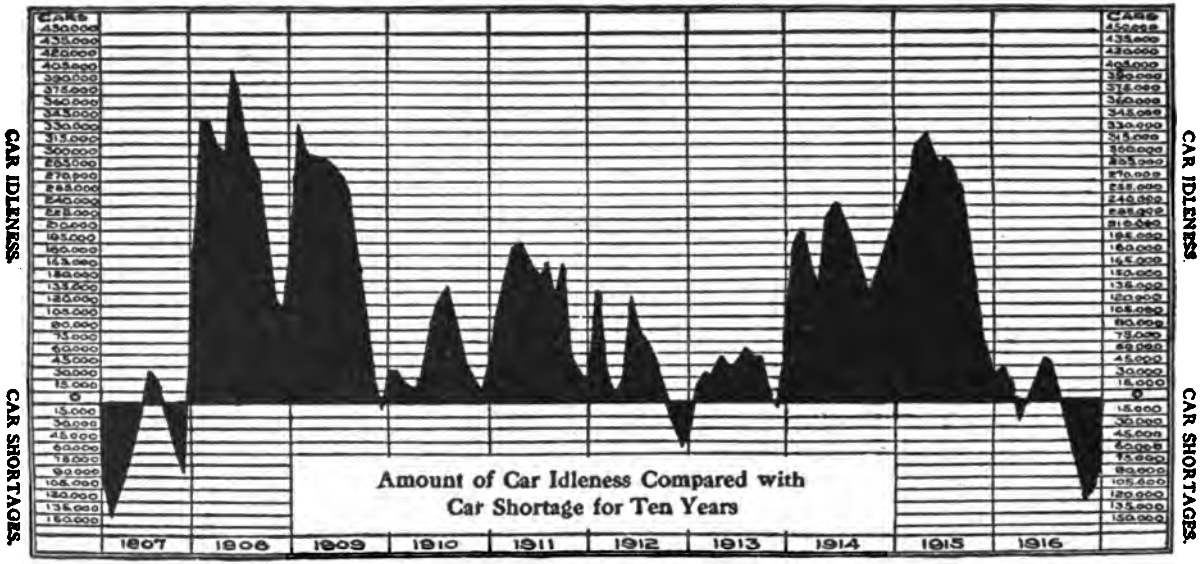

FIG. 34.—CAR IDLENESS COMPARED WITH CAR SHORTAGE.

FIG. 35.—INCREASE IN FREIGHT CARS AVAILABLE FOR SERVICE, 1916 CAR MILEAGE

"A"	"B"	"C"	"D"	"E"	"F"	"G"	"H"	"I"
Years ended June 30	Revenue tons carried one mile	Loaded car miles	Average miles per car per day	Average car capacity	Average tons handled per loaded car	Per cent of average tons per car to average capacity	Average loading based on securing loading equal to 65.56% of capacity same as 1918	Aggregate carrying capacity, tons
1906	215,877,551,241	11,410,599,327	(a) 24.8	32	18.92	59.12	20.98	59,059,302
1907	236,601,390,103	12,021,325,746	(a) 23.6	34	19.67	57.85	22.29	67,033,324
1908	218,381,554,802	11,128,231,436	(a) 21.2	35	19.62	56.05	22.95	73,086,522
1909	218,802,986,929	11,360,655,079	(a) 22.0	35	19.26	55.03	22.95	73,137,546
1910	255,016,910,451	12,851,294,922	(a) 23.6	36	19.85	55.13	23.60	78,578,735
1911	253,783,701,839	12,859,386,325	(a) 23.3	37	19.74	53.35	24.26	81,077,028
1912	264,080,745,058	13,088,331,845	(a) 23.2	37	20.18	54.54	24.26	82,965,418
1913	301,398,752,108	14,271,944,094	(a) 24.6	38	21.12	55.58	24.91	86,978,145
1914	288,319,890,210	13,669,210,232	(a) 23.8	39	21.09	54.08	25.57	90,977,098
1915	276,830,302,723	12,939,535,070	(a) 22.7	40	21.39	53.47	26.22	92,848,095
1916	343,099,937,805	15,155,643,733	(a) 26.9	40	22.64	56.60	26.22	93,613,653
†1917	394,382,077,643	15,774,819,213	(b) 26.1	40	25.00	62.50	26.22	94,590,533
†1918	398,442,019,620	14,823,569,433	(b) 24.9	41	26.88	65.56	26.88	96,545,239
†1919	362,962,480,000	14,225,829,000	(b) 23.1	41	25.51	64.66	26.88	*98,400,000

(a) Interstate Commerce Commission data.
(b) United States Railroad Administration data.
* Estimated.

YEARS 1906 TO 1919, INCLUSIVE, IF 1918 CAR LOADING AND FIGURES HAD APPLIED

"J"	"K"	"L"	"M"	"N"	"O"	"P"	"Q"
Total number of cars	Total number of cars required if 1918 loading as per Column "H," had been attained	Additional surplus based on loading of 65.56% of capacity as in 1918 (Column "H") and no increase in mileage (Column "D")	Additional surplus secured on basis 26.9 miles per car per day as in 1916	Additional surplus based on loading of 65.56% of capacity as in 1918 (Column "H") based on mileage of 26.9 per car per day	Additional surplus based on 26.9 miles per car per day as in 1916 and loading of 65.56% of capacity as in 1918 (Column "H")	Surplus or shortage shown in Slason Thompson report	Net adjusted surplus or shortage
1,833,635 *78,763*	1,653,562	180,073	143,182	166,012	309,194		309,194
1,986,017 *91,064*	1,752,574	233,443	243,591	204,810	448,401	‡22,821	425,580
2,096,234 *96,762*	1,557,862	264,369	386,047	208,361	594,408	274,003	868,411
2,071,338 *99,090*	1,578,870	302,512	342,671	246,873	589,544	189,956	779,500
2,133,531 *108,115*	1,744,020	329,445	254,317	289,038	543,355	60,066	603,421
2,195,331 *114,006*	1,686,015	386,097	277,299	334,428	611,727	123,219	734,946
2,215,239 *115,635*	1,817,869	367,573	300,466	317,037	617,503	29,797	647,300
2,273,289 *120,244*	1,888,951	339,067	190,507	310,075	500,582	45,271	545,853
2,325,647 *124,709*	1,761,528	374,148	246,032	331,046	577,078	189,971	767,049
2,258,855 *98,752*	1,665,534	376,077	318,733	317,365	636,098	217,244	853,342
2,236,312 *99,190*	1,931,018	305,294		305,294	305,294	‡8,149	297,145
2,384,765 *125,051*	2,273,803	110,962	70,808	107,667	178,475	‡97,997	80,478
2,385,476 *159,944*			176,173		176,173	15,373	191,546
*2,400,000	2,277,688	122,312	339,030	105,034	444,064		444,064

† Years ended December 31st for Class I Railroads only.

‡ Denotes shortage.

Figures in italics denote work equipment in Company service. Not included in computation.

weeks in the fall should be supplied under penalty of standing idle during the remainder of the year.

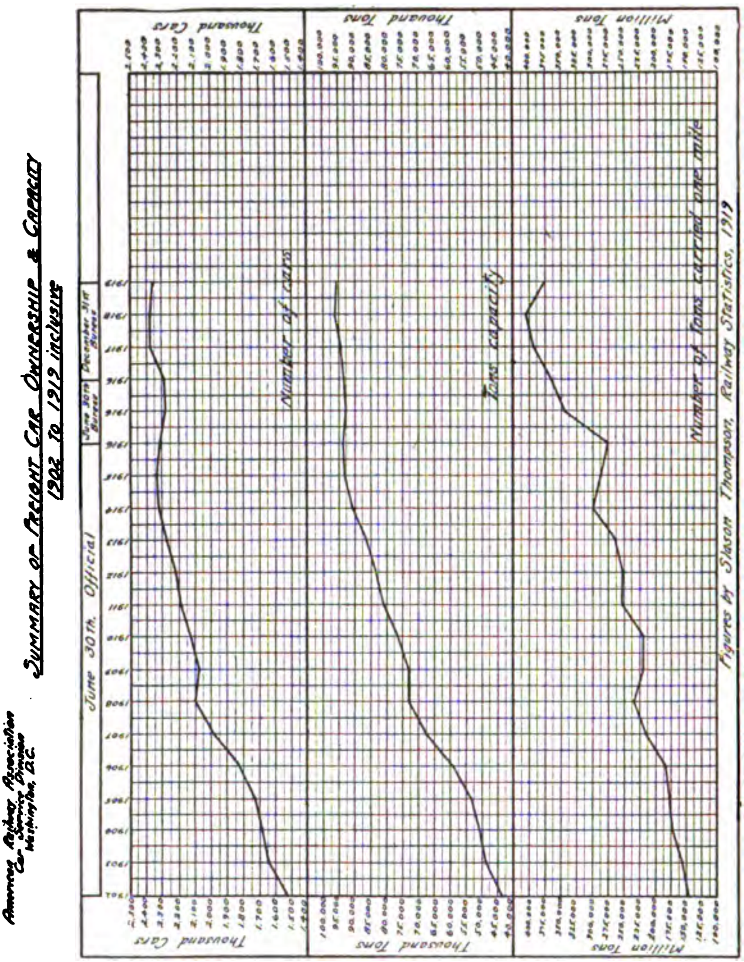

FIG. 36.—SUMMARY OF FREIGHT CAR OWNERSHIP AND CAPACITY.

In illustration of this relation of transportation to a single industry, the following excerpts are quoted from a recent report by A. G. Gutheim, of the American Railway Association:

The bituminous coal mining industry in this country is much overdeveloped.

We had two lean years before the war, and consumer's stocks were low.

The demand arose overnight and by midsummer, 1916, had reached extraordinary proportions; the 1915 production of 442,622,000 rose in 1916 to 579,386,000, an increase of 39 per cent.

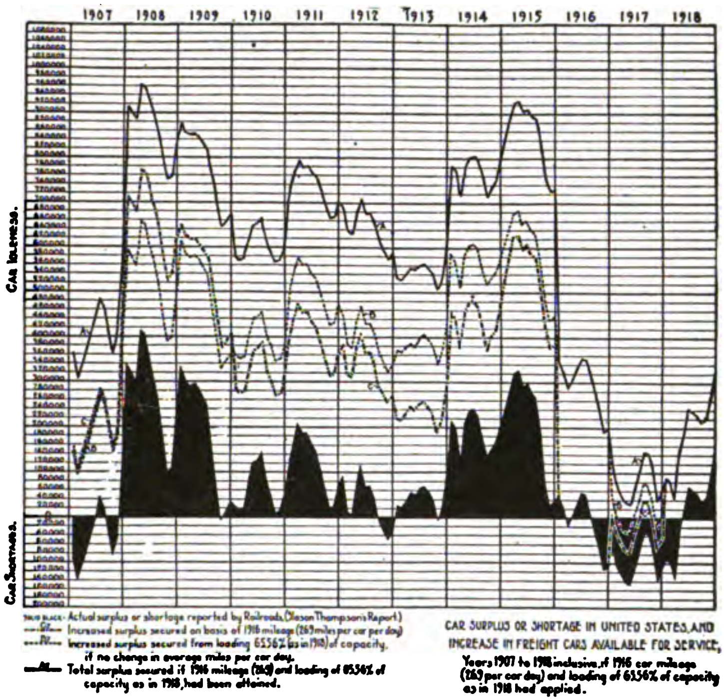

Fig. 37.—Car Surplus or Shortage in United States.

The military needs of the government were absorbing all lumber and steel supplies, and it was impossible to add to the locomotive or car supply. Nor was any control exerted over the marketing of the coal.

Nevertheless the stock of coal never ran below 25,000,000 tons, and reached 68,000,000 on Armistice Day. The solution was not dependent upon more transportation. It could have been solved as well or better by more economic distribution by the coal producers.

FIG. 38.—INCREASE POSSIBLE IN TONS ONE MILE, YEARS 1918 CAR LOADING AND 1916 CAR

Years ended June 30	Average miles per car per day	Average car capacity	Average tons handled per loaded car	Per cent of average tons per car to average capacity	Average loading based on securing loading equal to 65.56% of capacity same as 1918	Aggregate carrying capacity, tons	Cars available, I. C. C. figures	Less surplus shown in Sisson Thompson report	Number of cars used to carry revenue tons one mile	
									Cars	Ton-miles
1906	(a) 24.8	32	18.92	59.12	20.98	59,059,302	1,833,635 *78,763*		1,833,635	215,877,551,241
1907	(a) 23.6	34	19.67	57.85	22.29	67,033,324	1,986,017 *91,064*		1,986,017	236,601,390,103
1908	(a) 21.2	35	19.62	56.05	22.95	73,086,522	2,096,234 *96,762*	274,003	1,822,231	218,381,554,802
1909	(a) 22.0	35	19.26	55.03	22.95	73,137,546	2,071,338 *99,090*	189,956	1,881,382	218,802,986,929
1910	(a) 23.6	36	19.85	55.13	23.60	78,578,735	2,133,531 *108,115*	60,066	2,073,465	255,016,910,451
1911	(a) 23.3	37	19.74	53.35	24.26	81,077,028	2,195,331 *114,006*	123,219	2,072,112	253,783,701,839
1912	(a) 23.2	37	20.18	54.54	24.26	82,965,418	2,215,239 *115,635*	29,797	2,185,442	264,080,745,058
1913	(a) 24.6	38	21.12	55.58	24.91	86,978,145	2,273,289 *120,244*	45,271	2,228,018	301,398,752,108
1914	(a) 23.8	39	21.09	54.08	25.57	90,977,098	2,325,647 *124,709*	189,971	2,135,676	288,319,890,210
1915	(a) 22.7	40	21.39	53.47	26.22	92,848,095	2,258,855 *98,752*	217,244	2,041,611	276,830,302,723
1916	(a) 26.9	40	22.64	56.60	26.22	93,613,653	2,236,312 *99,190*		2,236,312	343,099,937,805
†1917	(b) 26.1	40	25.00	62.50	26.22	94,590,533	2,384,765 *125,051*		2,384,765	394,382,077,643
†1918	(b) 24.9	41	26.88	65.56	26.88	96,545,239	2,385,476 *159,944*	15,373	2,370,103	398,442,019,620
†1919	(b) 23.1	41	25.51	64.66	26.88	*98,400,000	*2,400,000		*2,400,000	362,962,480,000

(a) Interstate Commerce Commission data.
(b) United States Railroad Administration data.
* Estimated.

1906–1919, INCLUSIVE, IF IDLE CARS HAD BEEN USED AND IF MILEAGE FIGURES HAD APPLIED

Additional tonnage had surplus cars reported by Slason Thompson been used	Additional tons one mile if loading of 65.56% of capacity as in 1918 and no increase in mileage	Additional tons one mile if all cars were used and 26.9 miles per car per day were attained as in 1916	Additional tons one mile due to loading 65.56% of capacity as in 1918 and mileage of 26.9 miles per car per day as in 1916	Additional tons one mile based on 26.9 miles per car per day as in 1916 and loading of 65.56% of capacity as in 1918	Total revenue tons one mile if Slason Thompson surplus had been used based on 26.9 miles per car per day as in 1916 and loading of 65.56% of capacity as in 1918
	23,509,065,330	18,173,240,834	25,488,131,256	43,661,372,090	259,538,923,331
	31,526,305,161	33,076,874,336	35,921,144,823	68,998,019,159	305,599,409,262
32,837,341,529	42,631,846,707	67,527,639,333	54,091,287,102	121,618,926,435	372,837,822,766
22,091,692,844	46,155,420,644	53,647,244,185	56,404,778,440	110,052,022,625	350,946,702,398
7,387,517,340	49,568,196,409	36,684,139,206	56,497,830,306	93,181,969,512	355,586,397,303
15,091,370,244	61,572,391,507	41,541,198,636	69,985,325,995	111,526,524,631	380,401,596,714
3,721,386,292	54,149,580,849	42,689,243,737	62,781,356,043	105,470,599,780	373,272,731,130
6,124,125,067	55,200,356,453	28,753,389,015	60,361,589,781	89,114,978,796	396,637,855,971
25,646,464,942	66,686,453,834	40,878,194,408	75,368,982,327	116,247,176,735	430,213,531,892
29,456,982,936	69,159,669,102	56,663,147,846	81,954,207,885	138,617,355,731	444,904,641,390
	54,244,099,367		54,244,100,167	54,244,100,167	397,344,037,972
	19,245,845,389	12,068,091,575	19,834,768,258	31,902,859,833	426,284,937,476
2,583,494,142		32,202,348,755		32,202,348,755	433,227,862,517
	19,491,085,176	64,945,315,411	22,978,648,614	87,923,964,025	450,886,444,025

† Years ended December 31st for Class I Railroads only.

Figures in italics denote work equipment in Company service. Not included in computation

The Fuel Administrator for New England stated that removing coal-carrying vessels from coastwise service was equivalent to pulling up a four-track railroad in his section. This movement, as compared with rail and ocean, doubled the number of car-days. Further, the seaboard, or littoral, was subjected now for the first time to the competition of foreign buying.

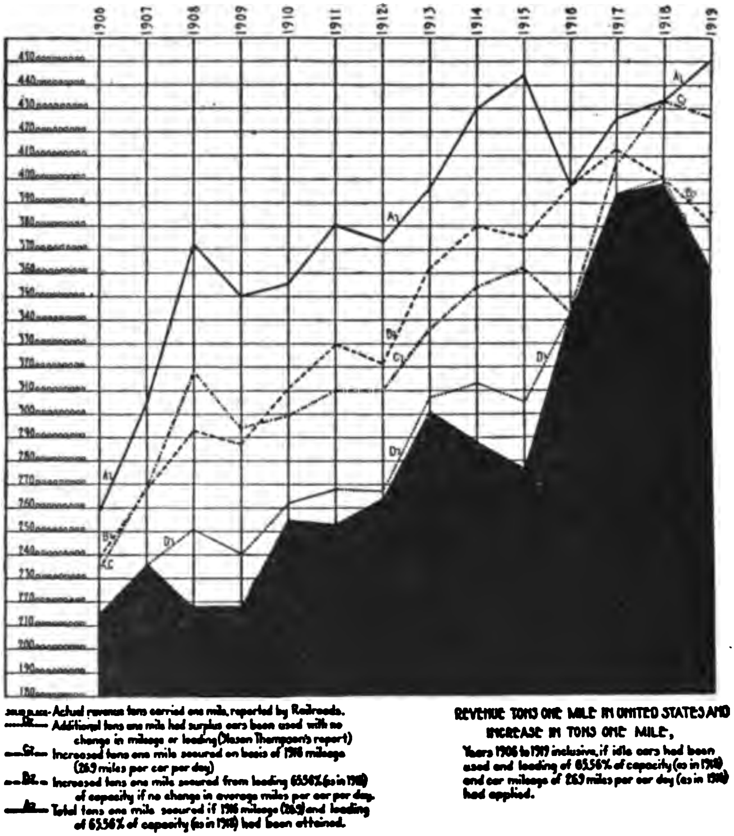

FIG. 39.—REVENUE TONS ONE MILE IN UNITED STATES.

The laws, the regulations of the Interstate Commerce Commission, the carriers' rates and practices, all prohibited discrimination at a time when intelligent and conscientious discrimination was the only remedy. This was ameliorated by the Lever Act and the Transportation Priority Act of 1917.

The arbitrary action made possible the complete protection of the Northwest served through the Great Lakes in the severe winter of 1917–18, and led to the development of the zoning system.

The mines have approximately a potential capacity to produce bituminous coal of 18,500,000 tons weekly, or considerably over 900,000,000 tons per annum. On this basis a theoretical shortage of 20 to 30 per cent in the car supply can always be claimed though the market could not take the output nor could the cars be used.

FIG. 40.—CAR SHORTAGE AND SURPLUSES, YEARS 1907 TO 1918, INCLUSIVE [1]

	Total Surpluses	Total Shortages	Net Surpluses
January	1,199,713	237,242	962,471
February	1,343,114	345,032	998,082
March	1,318,678	265,184	1,053,494
April	1,654,546	253,924	1,400,622
May	1,740,374	188,627	1,551,747
June	1,711,643	110,649	1,600,994
July	1,642,667	77,682	1,564,985
August	1,209,444	33,776	1,165,668
September	750,523	105,098	645,425
October	415,681	249,467	166,214
November	474,349	349,969	124,380
December	887,945	259,302	628,643

[1] The surpluses and shortages shown above are the *totals* for the months indicated for the 12 years, 1907 to 1918, inclusive. For example, in the 12 Januarys there were surpluses *totaling* 1,199,713 cars and shortages *totaling* 237,242 cars, leaving a net surplus of 962,471 cars.

As a consequence of the great accumulation on Armistice Day and the immediate slackening of mines, the production, which had averaged 12,000,000 tons weekly, fell at once to 10,000,000, and a little later to 8,250,000, while the railroads were carrying the greatest car surplus ever recorded, or 450,000 of all classes of cars daily, out of a serviceable ownership of 2,225,000, or 20.2 per cent.

The situation was again deranged by the bituminous mines strike, November–December, 1919. Much Eastern coal was moved West and at the cessation of the strike thousands of Eastern cars were tied up under load in the West for weeks.

The railroads were returned to the owners March 1, 1920, at which time the stocks had been reduced to 24,000,000 tons. Step by step the measures taken under the stress of war were abolished, traffic once more moved free of arbitrary control and discrimination, and we may now draw the lessons therefrom:

1. The bituminous coal-mining industry is developed far beyond present or immediate future demands of domestic and foreign trade.
2. The railroad facilities are adequate to-day to handle the necessary bituminous output.
3. The railroad facilities are not handling, and, without great waste of investment, never can handle production as under war conditions, with weekly peaks of 13,000,000 and valleys of 7,500,000 in a single year.
4. These extreme variations not only unduly burden the railroads, but invite further overdevelopment and produce great irregularity in the working time of the miners.
5. Through railroad regulations production may be forced, but distribution can be controlled but slightly and prices not at all.
6. The railroads should secure and compile correct and complete statistics of production, distribution, consumption, and stocks of bituminous coal, and relieve themselves of the false position in which they have been put by misleading figures furnished by interested parties.
7. Finally, we must endeavor reasonably to balance production, transportation, distribution, and consumption. All the blame cannot be placed on the shoulders of the railroads alone.

150. The Demands of the Traffic and the Provisions for Meeting Them.—It is evident then that, to meet the demands of the traffic, recourse may be had to two courses of action.

(*a*) *The Necessity for Balancing All the Factors Involved in the Movement.*—In the growth of the American railways there has accumulated, from a variety of causes, a supply of freight equipment that is out of proportion in its relation to the other elements which alone make its use economical and adequate. Any substantial additions to the freight equipment stock would involve a large additional investment and heavy upkeep expense, with a large amount of equipment standing idle over the major portion of the year and a substantial increase in all the freight movement elements of the railroad.

For the fullest and most economical use of a railroad there must be a balance of its several parts, that is, an equilibrium determined by the volume and character of traffic must be maintained between the main tracks and sidings, the working yards and delivery tracks, the number of locomotives, the number of passenger cars, the number of freight cars, and the shop facilities for caring for the equipment. Great progress may be made through intelligent study of their own

transportation problems on the part of the interested carriers. Too often it is taken for granted that relief from an apparent car shortage is afforded by buying more cars, when the real need is greater facilities to move the cars already available or higher efficiency in their utilization. As long ago as 1893, at a time of great business activity, I find E. B. Thomas saying: "I believe and have believed for several years that there is a sufficient freight car equipment in this country to more than do the business under ordinary circumstances." Many years ago the Interstate Commerce Commission consolidated, in their published statistics, the items of "Road" and "Equipment" in the "Balance Sheet," but according to the Commission's estimated cost of reproduction new of the roads reported on to April 30, 1920, it would appear that upon a line having ample rolling stock the value of the equipment is not likely to be less than 25 per cent of the total, including the general accounts. This indicates that for each dollar spent for new equipment three additional dollars would have to be spent to provide for its economical use.

(*b*) *The Factors Affecting the Best Possible Use of the Cars.*—The serviceability of the existing equipment can be substantially increased by intelligent coöperation between the railroads and the traders, and both should give attention to the factors affecting the best possible use of cars.

After the passage of the Sherman Act and the extended construction given it by the courts, railroad officers avoided action that might even be fancied as offensive to the Act. George F. Baer, who frequently presided at meetings, used always to open them with the explanation that, while joint routes and divisions might properly be discussed, no consideration of rates was permissible, and, were any to be suggested, he for one would leave the conference. These inhibitions proved so impractical that gradually a *modus vivendi* was resorted to under which practices having to do with the fixing of rates or costs were discussed for the purpose of publishing them subject to the approval of the Interstate Commerce Commission, which had fallen into the practice of suspending all new rates pending inquiry. This method,

though awkward, costly, and the subject of much delay, can be worked, but it has about it so much of the quality of "let George do it" that very little is accomplished.

The matters that militate against the best use of the freight cars are those that fall under the control of the Interstate Commerce Commission, as:

Minimum weights
Reconsignment
"To order" bills of lading
Transportation of explosives
Collection and delivery
Demurrage
Private cars

Those that are the immediate concern of other public authorities or of the traders, as:

Facilities furnished by public authority
Plant facilities

And those over which the railroads have full control, as:

Yard handling
Trap or ferry cars
Car records
Tracing
Road handling
Bad order cars
Sailing dates
Loaded and empty mileage
Car pools
Per diem
Car service rules
Embargoes, with and without permits
M. C. B. Rules
Obligations of the roads to furnish cars

151. Minimum Weights.—An aid to the heavier loading of cars would be the raising of the minimum weights for carload shipments, and this is especially important in the loading of cars moving in the direction of the preponderating

FIG. 41.—CARLOAD FREIGHT

	1st Quarter		2d Quarter		3d Quarter		4th Quarter		Total, Year 1920		Average loading
	Number of Cars	Number of Tons (2000 Pounds)	Number of Cars	Number of Tons (2000 Pounds)	Number of Cars	Number of Tons (2000 Pounds)	Number of Cars	Number of Tons (2000 Pounds)	Number of Cars	Number of Tons (2000 Pounds)	Tons (2000 lbs.)
Products of Agriculture.	1,172,342	28,109,847	860,339	20,633,142	1,044,663	26,734,522	1,383,097	35,404,174	4,460,441	110,881,685	25
Products of Animals. . .	583,538	6,960,967	528,500	6,372,393	529,119	6,374,286	577,613	6,838,198	2,218,770	26,545,844	12
Products of Mines.	3,042,128	143,323,954	3,483,748	169,627,265	4,271,478	206,148,332	4,010,562	198,413,417	14,807,916	712,512,968	48
Products of Forests. . . .	901,322	25,575,364	964,115	26,448,627	984,314	26,585,525	829,583	23,003,693	3,679,334	101,613,209	28
Products of Manufacturers and Miscellaneous.	2,308,105	58,399,996	2,455,669	63,083,573	2,742,037	71,369,465	2,181,053	58,313,960	9,686,864	251,166,994	26
Total.	8,007,435	262,370,128	8,292,371	286,165,000	9,571,611	337,212,130	8,981,908	316,973,442	34,853,325	1,202,720,700	34

Fig. 42.—Summary of Freight Commodity Statistics of Class I Roads for the Quarter Ended December 31, 1920, as Reported by the Interstate Commerce Commission

(Class I Roads are those having annual operating revenues above $1,000,000)

Commodity	United States		
	Revenue Freight Originating on Respondent's Road		
	Number of Carloads	Number of Tons (2000 lbs.)	Average Tons per Car
Products of Agriculture			
1. Wheat	179,381	7,350,647	40.97
2. Corn	73,795	2,706,937	36.68
3. Oats	58,917	1,913,205	32.47
4. Other Grain	46,806	1,628,353	34.79
5. Flour and Meal	88,414	2,589,807	29.29
6. Other Mill Products	73,559	1,854,811	25.22
7. Hay, Straw and Alfalfa	140,086	1,746,457	12.47
8. Tobacco	22,342	243,003	10.88
9. Cotton	111,368	1,316,500	11.82
10. Cotton Seed and Products, except Oil	88,677	2,144,482	24.18
11. Citrus Fruits	21,149	339,616	16.06
12. Other Fresh Fruits	135,691	2,146,358	15.82
13. Potatoes	87,080	1,675,173	19.24
14. Other Fresh Vegetables	48,871	741,308	14.77
15. Dried Fruits and Vegetables	17,448	480,147	27.52
16. Other Products of Agriculture	189,513	6,527,370	34.44
Total	1,383,097	35,404,174	25.60
Products of Animals			
17. Horses and Mules	11,375	129,293	11.36
18. Cattle and Calves	246,972	2,865,942	11.60
19. Sheep and Goats	42,460	414,663	9.76
20. Hogs	138,269	1,331,903	9.63
21. Fresh Meats	52,898	692,226	13.09
22. Other Packing-house Products	31,054	530,419	17.08
23. Poultry	8,347	96,332	11.54
24. Eggs	6,614	76,061	11.50
25. Butter and Cheese	6,844	86,965	12.70
26. Wool	3,022	38,375	12.70
27. Hides and Leather	9,626	208,362	21.65
28. Other Products of Animals	20,132	367,657	18.26
Total	577,613	6,838,198	11.84

FIG. 42.—SUMMARY OF FREIGHT COMMODITY STATISTICS OF CLASS I ROADS FOR THE QUARTER ENDED DECEMBER 31, 1920, AS REPORTED BY THE INTERSTATE COMMERCE COMMISSION—*Continued*

(Class I Roads are those having annual operating revenues above $1,000,000)

Commodity	United States		
	Revenue Freight Originating on Respondent's Road		
	Number of Carloads	Number of Tons (2000 lbs.)	Average Tons per Car
Products of Mines			
29. Anthracite Coal	437,918	21,224,244	48.46
30. Bituminous Coal	2,221,754	110,522,086	49.74
31. Coke	195,203	6,871,501	35.20
32. Iron Ore	402,582	20,605,039	51.18
33. Other Ores and Concentrates	75,126	3,843,791	51.16
34. Base Bullion and Matte	2,701	120,918	44.77
35. Clay, Gravel, Sand and Stone	560,177	26,232,054	46.82
36. Crude Petroleum	46,047	1,590,738	34.54
37. Asphaltum	9,490	309,590	32.62
38. Salt	21,594	642,172	29.74
39. Other Products of Mines	37,970	1,451,284	38.22
Total	4,010,562	193,413,417	48.22
Products of Forests			
40. Logs, Posts, Poles and Cord Wood	316,299	9,002,866	28.46
41. Ties	68,122	2,074,207	30.45
42. Pulp Wood	40,431	1,194,296	29.54
43. Lumber, Timber, Box Shooks, Staves and Headings	373,844	10,085,694	26.98
44. Other Products of Forests	30,887	646,630	20.93
Total	829,583	23,003,693	27.73
Manufactures and Miscellaneous			
45. Refined Petroleum and Its Products	265,593	7,348,433	27.67
46. Vegetable Oils	9,865	280,270	28.41
47. Sugar, Sirup, Glucose and Molasses	39,205	1,162,731	29.66
48. Boats and Vessel Supplies	2,074	28,603	13.79
49. Iron, Pig and Bloom	81,536	3,782,519	46.39
50. Rails and Fastenings	21,186	843,540	39.81
51. Bar and Sheet Iron, Structural Iron and Iron Pipe	204,923	7,187,170	35.07

FIG. 42. SUMMARY OF FREIGHT COMMODITY STATISTICS OF CLASS I ROADS FOR THE QUARTER ENDED DECEMBER 31, 1920, AS REPORTED BY THE INTERSTATE COMMERCE COMMISSION—*Continued*

(Class I Roads are those having annual operating revenues above $1,000,000)

Commodity	United States		
	Revenue Freight Originating on Respondent's Road		
	Number of Carloads	Number of Tons (2000 Lbs.)	Average Tons per Car
Manufactures and Miscel.—*Cont.*			
52. Other Metals, Pig, Bar and Sheet	33,002	1,160,284	35.16
53. Castings, Machinery and Boilers	91,342	2,079,891	22.77
54. Cement	105,365	3,924,667	37.24
55. Brick and Artificial Stone	92,722	3,258,698	35.14
56. Lime and Plaster	36,618	1,059,478	28.93
57. Sewer Pipe and Drain Tile	25,094	484,610	19.31
58. Agriculture Implements and Vehicles Other than Automobiles	39,322	626,036	15.92
59. Automobiles and Auto Trucks	92,215	703,149	7.62
60. Household Goods and Secondhand Furniture	36,703	364,821	9.94
61. Furniture (New)	13,027	132,541	10.17
62. Beverages	10,603	220,693	20.81
63. Ice	30,074	773,969	25.73
64. Fertilizers (All Kinds)	37,083	981,935	26.48
65. Paper, Printed Matter and Books	29,309	719,271	24.54
66. Chemicals and Explosives	63,909	1,987,141	31.09
67. Textiles	10,362	139,362	13.44
68. Canned Goods (All Canned Food Products)	33,736	840,705	24.92
69. Other Manufactures and Miscellaneous	776,185	18,223,413	23.48
Total	2,181,053	58,313,960	26.73
Grand Total, Carload Traffic	8,981,908	316,973,442	35.29
70. Merchandise All L.C.L. Freight	....	11,938,705	
Grand Total, Carload and L.C.L. Traffic	....	328,912,147	

current of loaded traffic, as it would have the effect of reducing both the number of loaded cars to be moved and empty car mileage in the return direction. As an example, approximately 60 per cent of the cars going into New England loaded now return empty, and to the extent heavier loading can be obtained the number moving into New England could be lessened and the empty mileage correspondingly reduced.

The statement is commonly made that the average marked capacity of the freight car is 41 tons, that the average loading of the car has reached at best 26.8 tons in 1918, and that this percentage of use, 65.56, is most wasteful. But this presentation of the case is inexact and, by failing to take into consideration the character of the traffic offered for movement and the limitation thereby imposed, does justice neither to the railroads nor to the traders. Unfortunately the data that would illuminate this subject are meager.

The Interstate Commerce Commission requires the companies to report the loading of some 70 commodities, and the results for the Class I roads for the year 1920 for carload freight are shown in Figure 41. I have supplemented this by Figure 42, showing the detailed results for the last quarter of 1920.

The Interstate Commerce Commission in its statistics of railroads for the year 1918 gives in some detail the revenue freight tonnage by classes of commodities.

REVENUE FREIGHT TONNAGE BY COMMODITIES—CLASS I, CARRIERS

Commodity	Total Freight Tonnage	Per Cent of Aggregate
Products of Agriculture	228,322,331	9.90
Products of Animals	61,404,525	2.66
Products of Mines	1,263,502,734	54.76
Products of Forests	192,616,711	8.35
Products of Manufacturers	377,366,031	16.36
Miscellaneous	85,645,364	3.71
L. C. L. not included above	98,368,439	4.26
Total	2,307,226,135	100.00

The Association of Transportation and Car Accounting Officers issued during the year 1918 monthly statements and summaries covering car loading. Taking the highest average so reported and applying these averages against the number of tons of each commodity, the number of cars that would have been required for the movement may be estimated for about 90 per cent of the tonnage. For the other 10 per cent an approximation may be made from the Interstate Commerce Commission Summary of Freight Commodity Statistics for the quarter ending June 30, 1920. Dropping all fractions in favor of the heavier tons per car, and applying to the entire movement the highest average made by any Class I road, a weighted average loading per car is obtained of 32.4 tons.

In March, 1920, the American Railway Association, in the conduct of its campaign for intensive loading of freight car equipment, having set a goal of "30 tons per car," undertook the collection of data with respect to the loading of L.C.L. and carload freight. From the reports (Form S.V. 32) made to the Association, Figures 43 and 44 have been compiled:

FIG. 43.—LOADING OF L.C.L. FREIGHT

1920	Number of Roads Reporting	1920			1919		
		Number Cars	Tons Loaded	Average Tons per Car	Number Cars	Tons Loaded	Average Tons per Car
January....	194	846,832	6,401,727	8	703,020	5,267,588	7
February...	174	740,708	5,836,153	8	673,933	4,901,042	7
March.....	142	849,796	6,875,675	8	710,057	5,226,832	7
April......	146	701,040	5,353,876	8	759,006	4,984,419	7
May.......	155	787,599	5,135,173	7	873,273	6,277,450	7
June.......	153	794,263	6,171,855	8	859,023	6,097,692	7
July.......	157	829,540	6,316,043	8	906,544	6,334,709	7
August.....	159	846,770	6,539,271	8	863,329	6,229,782	7
September..	156	837,256	6,417,688	8	922,222	6,906,228	8
October....							
November..			Reports	discon	tinued		
December..							
Total...	..	7,233,804	55,047,461	8	7,270,407	52,225,742	7

FIG. 44.—LOADING OF CARLOAD FREIGHT

Month	1920				1919			
	Number of Roads Reporting	Weight of Commodity Loaded into Cars, Pounds	Average Weight of Lading per Car, Pounds	Per Cent of Capacity Used [1]	Number of Roads Reporting	Weight of Commodity Loaded into Cars, Pounds	Average Weight of Lading per Car, Pounds	Per Cent of Capacity Used [1]
January	55	37,437,053,139	84,175	85.6	63	34,129,512,319	94,733	98.2
February	56	31,757,829,546	82,940	85.8	62	23,699,441,441	85,969,	88.9
March	68	40,689,447,323	85,492	85.1	61	17,921,800,154	85,813	87.5
April	59	25,636,985,879	71,084	84.1	55	22,343,307,189	80,319	83.7
May	73	45,814,947,223	87,334	88.9	56	34,825,849,252	86,342	85.0
June	74	53,412,495,476	88,015	80.1	54	37,500,756,520	78,781	81.8
July	72	50,491,838,686	88,807	89.1	58	32,316,722,741	63,462	70.9
August	78	51,412,541,629	87,869	88.4	56	49,838,894,290	89,538	77.9
September	74	52,821,760,355	88,487	88.2	61	44,814,662,725	89,975	86.5
October								
November		Reports discon	tinued					
December								
Total	..	389,474,899,256	84,911	86.1	..	297,390,946,631	83,881	84.5

[1] The "nominal capacity" of the car under Master Car Builders rule 86, plus 10 per cent, is taken as the loading availability and the figures in this column represent per cent of car capacity utilized regardless of specific gravity or bulky nature of commodity reported upon.

I submitted the problem to the Western Classification Committee and to the Trans-Continental Freight Bureau, who replied that they kept no data; the Southern Classification Committee, the Trunk Line Association and the American Railway Association all submitted estimates stating that it was quite impossible to give more than rough approximations. It is evident that the traffic moving in the three great traffic regions of the country varies so greatly in its character as vitally to influence the possibilities of maximum loading.

From these data, such as they are, from discussions with transportation officers, and from other studies, I draw the following conclusions:

L.C.L.—In trunk line territory 17.8 per cent of the cars are loaded with less than carload lots, while in New England territory 29.1 per cent, in Southern territory 26.9 per cent, and in Western territory 21.2 per cent, of the cars are so loaded, or a weighted average of 20.6 per cent. That is, about 20.6 per cent of the cars are loaded with L.C.L. freight, the loading ranging from 4 tons to 12 tons.

Carload.—This business is principally moved under tariffs prescribing commodity rates, of which there are literally thousands, covering perhaps 76 per cent of the whole, or, under class rates, covering 24 per cent of the whole, the number of which varies in the different regions but is likely soon to be standardized into ten class rates with additional modifications in some of the classes as "A," double "A," etc.

There are in the "Official Classification" 1,643 carload entries, of which 45 cover very light and bulky articles. A canvass was made of an 18-day movement covering 4,646 cars in which were moved 106 commodities; of these, four commodities were loaded less than the minimum, utilizing 14 cars. Practically all the other commodities, while loaded to the minimum, might have been loaded much heavier than the highest minimum weight fixed in the tariffs, which minimum weights should be materially increased.

It seems probable that 5 per cent of the cars are loaded

with light articles weighing 10 pounds or less per cubic foot, such as hay, straw, excelsior, tanbark, furniture, vehicles, utensils, live stock, fresh meats, fruits, vegetables, etc.

Probably 9 per cent of the cars are loaded with articles which would not be considered as very light articles in themselves but nevertheless would not load more than 50 per cent of the car weight-capacity, such as cork, chairs, corn silk, wooden bedsteads, benches, desks, kettles, file cabinets, etc.

The remaining 66 per cent of the cars are used for the movement of articles which can be loaded to the full weight-capacity of the cars. These are commodities that move in large volume, such as coal, coke, limestone, iron ore, grain, fertilizers, lumber, brick, stone, etc.

There were 2,393,962 railway-owned revenue freight cars in service in the United States on March 1, 1920. Using the round figure 2,400,000 and applying these percentages we get the following rough approximation:

RAILWAY-OWNED FREIGHT CARS

Character of Business	Per Cent of Whole	Cars Used	Estimated Loading Obtainable, Tons	Total Tons That Could be Handled
L.C.L.	20	480,000	12	5,760,000
Car load				
Commodities				
Light	5	120,000	12	1,440,000
Medium	9	216,000	25	5,400,000
Heavy	66	1,584,000	40	63,360,000
Total	100	2,400,000	..	75,960,000

This would indicate a weighted average loading obtainable per car of 31.65 tons.

If we are to take the average capacity of the car for loading at 41 tons and are able to secure an average loading of 30 tons we seem to realize only 73.2 per cent of the theoretical perfection, but if we are to take the average possible attainment of car loading, having in view both the

capacity of the car and the character of the business moved, and fix this at 31.65 tons, then if we secure an average loading of 30 tons we seem to realize 94.8 per cent of the practical perfection and it is with this alone that the railroads and the traders are fairly chargeable.

Nevertheless the 5 per cent of capacity not used involves vast wastes and must be resolutely, energetically, and continuously attacked. If the 2,307,226,135 tons reported as moved in 1918 had been loaded at the average of 31.65 tons per car, each of the 2,393,962 cars would have been loaded 30.4 times during the year, or at intervals of 12 days. This would, of course, necessitate a corresponding improvement in car handling to reduce the time of the round trip.

Perhaps 20 per cent of the total tonnage is of articles which could be loaded heavily but are, as a matter of fact, loaded lightly because of commercial practice or some saving in expense to the shipper. Much has been done by the railroads in obtaining changes in commercial practices by pressure on shippers, coincident with the increasing capacity of cars and especially in times of car shortage, but the most potent influence that could be brought to bear would be raising the minimum weights in the rate structure and this should have the earnest attention of traffic officers and of the Interstate Commerce Commission.

In a review of the railroad situation, Thomas DeWitt Cuyler, chairman of the Association of Railway Executives, on December 27, 1920, pointed out that in the nine full months following the return of the railroads to their owners on March 1, 1920, they had under private operation:

1. Increased the average movement per freight car per day 6.3 miles, from 22.3 to 28.6 miles.
2. Increased the average load per car 1.7 tons, from 28.3 to 30 tons.
3. Reduced the accumulation of loaded but unmoved freight cars from 103,237 on March 1, to 21,991 on December 3, of which only 6,386 were detained because of the inability of the railroads to move them.
4. Relocated approximately 180,000 box cars from the East to the West for the movement of farm produce.

5. Relocated approximately 180,000 open-top cars from the West to the East to keep up the production of coal.
6. Moved the third highest coal production in the history of the country.
7. Contracted to spend about $250,000,000, largely without the issue of additional securities, for additions and betterments to promote the movement of cars.
8. Begun the reconstruction of thousands of old cars.
9. Moved, with a deteriorated plant, under disturbed labor and business conditions, the largest volume of traffic ever known in a single year, with the highest efficiency yet achieved, and with a minimum addition to the value of the property on which the public has to pay a return through rates.

He quoted Interstate Commerce Commissioner Aitchison, who had been in direct charge of car service matters for the Commission, as saying:

The condition in the spring of 1920 was more menacing to the domestic welfare of the country than it was in the early winter of 1917 when federal control was assumed. But the situation was met, squarely and courageously, in a businesslike way, without political interference or pressure of any character whatsoever, under the orderly processes of law, by privately operated railroads, directed along consistent lines to secure that unity of object and policy which was the end sought in placing the carriers under federal control during the war.

He further quoted from the annual report of the Interstate Commerce Commission, filed with Congress on December 9, 1920, as follows:

Comparing August, 1920, with August, 1919, the increased mileage had the effect of increasing the car supply 287,694 cars; the increased tonnage per car had the effect of increasing the car supply approximately 104,942 cars.

The *Railway Age* some time ago conducted a contest on "means of increasing car mileage," and from the suggestions there brought out I give the following:

OPERATION

1. Speed up movement through terminals.
2. Interchange cars more promptly.

3. Forget division limits and increase length of train runs regardless of whether or not it makes a good showing for one division and a poor showing for another.
4. Too many terminals causes too much switching with resultant delay.
5. Prompt and dependable switching service.
6. Reduce delay in movement after loading and place for unloading promptly.
7. Reduce delay in removing empty cars from industrial sidings. Very bad example to urge prompt unloading and then permit empty cars to remain on sidings until the following day.
8. Pay more attention to switching shop tracks.

Supervision

1. Know every car on the road.
2. Assign car efficiency expert to analyze every phase of situation; supervise movement; check and surprise-check yards; check waybills through yards.
3. Efficiency expert to be given ample authority.
4. Check carefully all cars at stations, except live cars, and follow up delays.
5. Superintendent or other person in charge to handle all bad cases of delay by phone, letter, or personal interview.
6. Rigidly place and enforce embargoes when necessary.
7. Make an improvement in marshaling cars.
8. Agents and yardmasters keep close tab on every car.
9. Watch special cars such as stock, etc., to avoid idleness. Use for rough freight.
10. Check loading and unloading of company freight; reduce detention one half. Bad example for public to see cars lying around loaded with company freight.

Mechanical Department

1. Speed up bad order delays.
2. Hurry inspection of cars at interchange.
3. Keep sufficient material on hand to make repairs.
4. Equip yards with air lines to pump up trains before engines are coupled on.

Relations with Patrons

1. Encourage big industries to load and unload on Sundays.
2. Shippers should place orders for cars indicating first, second, and possibly third choice; shippers specify certain type when another type would answer.

3. Make cars fit commodity to be shipped.
4. Do not permit shippers to point out railroad delays by observation, even at greater expense of supervision, yard engines, etc.
5. Encourage shippers and consignees to load and unload more promptly.

General

1. Hold efficiency meetings, commend good handling.
2. Conduct a campaign on car movement, advertise it, get every one talking and arguing cars. Make it a topic at every railroad meeting.
3. Issue comparative statements of car handling at different points to get employees competing with one another. Speak of car delays in hours, not days.
4. Present day influences have reduced efficiency. Arouse old-time efficiency.

The *Railway Age* has also published articles on methods to secure full loading of cars, and from them I have picked out the following suggestions:

Utilization

1. Use high capacity cars for long hauls of heavy commodities.
2. Preferably use light capacity cars for short hauls or quick trips of light weight commodities.
3. Care in method of loading to obtain carrying capacity load.
4. Place cars that fit commodity to be shipped.
5. Load two carload shipments in one car for one or more destinations.
6. Company employees loading company freight expected to load cars as heavy as commercial freight shippers.
7. After urging heavy loading do not permit empty cars to stand on sidings for shippers to view.
8. L.C.L. merchandise is loaded by railroads themselves; therefore great opportunity to increase weight of lading per car.
9. Hold merchandise cars for sufficient tonnage and then card through rather than run with light load to near-by transfers. The delay caused by holding car for tonnage would be more than overcome by through movement.
10. If tonnage for single destination not sufficient for daily car, make it bi-weekly, tri-weekly, or other period, loading to two or more destinations or to transfer stations.

Supervision

1. Multiplicity of activities on a great railroad such that specialists are required to direct efforts of officers and employees to obtain desired results, and responsibility should be centered on some individual or bureau with traveling inspectors.
2. Chief duty of bureau to maintain interest in campaign for increased loading, establish standards adapted to various loading conditions and see that methods are uniform throughout the road.
3. Inspectors to visit large shippers and stations and instruct, offer helpful suggestions and keep question of heavy loading very much alive.
4. Keep records to compare monthly performance of various stations and industries.
5. Essential that complete and accurate records be made of loading and check for light loads or improper use of cars.
6. Brunt of campaign to be borne by operating and traffic officials to infuse in the organization the required efforts and activity, by staff meetings, personal interviews, and written instructions.
7. Concentrated efforts of the officers, other employees, and shippers brought to bear on problem in conjunction with efficient transportation will result in attainment of creditable loads.
8. Prevail upon consignees who order light loads to increase orders.
9. Take photograph records of light loads.

Mechanical

1. Increase carrying capacity of equipment.
2. Gondola cars with sides too low to hold capacity of coal, etc., should have sides raised where the underframe will carry the additional load and where the sides may be kept in alignment and prevented from bulging.

General

1. Establish minimum weight limit for carloads to apply unless cubical capacity determines load.
2. Classification minimum weights should be increased.
3. Less carload commercial freight requires considerable percentage of available box cars, average weight of lading being under 8 tons.
4. Coöperation of public very essential. Station agents in position to solicit coöperation and assistance of shippers and public.

This review of the car loading naturally suggests the question as to what is the economical vehicle. During the period of government control the Director-General ordered the construction of 100,000 freight cars upon designs made under his instructions and classified as follows:

Item	Number	Capacity, in Pounds
Single-sheath box	25,000	100,000
Double-sheath box	25,000	80,000
Low-side gondolas	5,000	140,000
Drop-bottom gondolas	20,000	100,000
Hopper-bottom gondolas	25,000	110,000

These proposed standards of equipment were not received with very much enthusiasm and are not likely to come into vogue. As one expression of opinion on the subject, Julius Kruttschnitt, chairman of the Executive Committee of the Southern Pacific Company, said:

After years of fruitless activity, the life of the A.R.A. Committee on Standard Box Car terminated with federal control. At the close of 1917, the Committee was divided in the consideration of two designs; one prepared by its sub-committee was estimated to weigh 46,000 pounds, and another, carefully proportioned by competent engineers to safely stand all stresses imposed by prescribed specifications, to weigh 40,738 pounds, drawings and computation sheets of which were sent to each member of the Committee, with the request that they be experted and criticized in order to detect errors; none were ever reported. Two structures of the same materials, designed for the same loads, allowances for shock, etc., must coincide closely in weight, yet as the sub-committee's car weighed nearly 5300 pounds more than the alternative design, inference of faulty design and improvident use of material cannot be escaped.

The U. S. R. R. A. car weighs 16.3 per cent or 3.3 tons more than a possible one of equal load and space capacity; hence we may expect an increase in its initial cost of about 16.3 per cent.

Center sills, draft sills, steel side, under- and end-framing, roof, doors, floor, trucks, etc., can be built lighter than those in U. S. R. R. A. car, and in every case materially stronger.

Based on U. S. R. R. A. statistics for 1919, the cost of hauling the excess 3.3 tons causes unnecessary and easily avoidable expense of millions of dollars per annum which might be saved by elimination of useless dead weight.

The improvidence of the U. S. R. R. A. box car design is illustrated thus: A train of 40 U. S. box cars loaded to 55 tons, contains 2200 tons paying load and weighs 944 tons; 42 carefully designed cars will carry 2310 tons and will weigh 853 tons, an excess of paying freight over the others of 110 tons. As the total weight of the two trains is the same, the cost of running them will be the same, but the 110 tons of additional paying freight, the haul of which is made possible by elimination of unnecessary dead weight, would bring in a revenue at existing ton mileage rates of $1.10 per train mile, every cent of which would be net. This is substantially 10 per cent more than the net earnings of the train of U. S. cars.

The slight attention given to weight by the designers of the U. S. R. R. Administration cars is shown by the fact that the 40-ton car designed at the same time weighs nearly as much as the 50-ton car. Excess weight will necessarily make the U. S. R. R. A. car cost more than a lighter car, roughly in proportion to weight. We ascertained in the latter part of 1917 that the car which we contrast with the U. S. R. R. A. car could have been built for between $2300 and $2400. The U. S. R. R. A. box contracted for in the early part of 1918 cost $3050.

The use of the lighter and stronger car, by saving expenses and adding revenue, increases net income by $329.45 per car per annum.

We must therefore ask ourselves:

1. Can we afford a design that will cost 16.3 per cent more than necessary?

2. Can we afford to use a car which we know (through improper design) will cost $101.18 more per annum to haul in freight trains than a stronger, lighter car would cost?

3. Can we afford, as standard, a car that cuts net earnings of fully laden freight trains each mile by $1.10 or 10 per cent?

It would appear that generally we may expect the box car of the immediate future to be of 80,000 to 100,000 pounds capacity; the men should be carefully drilled in the practice of setting the lighter car for L.C.L. loading.

In the open-top equipment few cars are likely to be built of less than 100,000 pounds capacity. On roads handling heavy mineral business cars of 140,000 pounds capacity, which is about the limit of service of the four-wheel truck, are becoming common, while on roads where this class of traffic can be moved in a relatively short-haul shuttle service, with special handling facilities at either end, cars of much greater capacity are beginning to be introduced.

At the Master Car Builders Convention at Atlantic City on June 18-23, 1919, the Pennsylvania Railroad exhibited two gondolas which they had built to show what they then considered the maximum capacity attainable, and these had a marked capacity of 210,000 pounds and 220,000 pounds respectively. A thousand steel gondola coal cars of 240,000 pounds capacity were put in service on the Virginian Railway in the latter part of 1920. They weigh 78,900 pounds, making the ratio of load to dead weight 75.3 per cent.

In fixing minimum weights it is held by many that the Interstate Commerce Commission should require the loading of the car to its marked weight carrying capacity or to its cubical content capacity, as the character of the lading justifies. Inasmuch as carrying capacity is 10 per cent above marked capacity, it is felt that this gives a reasonable margin for the shipper in the one case, and in the other proper packing will afford equal protection.

152. Reconsignment.—The traffic regulations permit cars to be reconsigned, diverted, reshipped, held for orders to switch to connections, stopped in transit, or set on hold tracks at destination and there held for disposition. The number of diversions permitted is usually unlimited. It is not uncommon for shipments to change hands from four to eight times before the final sale and distribution. Much of the service is performed free, but for some of it a nominal charge of $2.00 is made. In one state, of 64,678 cars diverted in one year, 95.79 per cent were free of cost, while an inadequate charge was collected upon only 4.21 per cent. The purpose of this practice was in the main to facilitate the distribution of shipments and especially of perishable foodstuffs, to build up certain classes of trade and to take care of fluctuating conditions through a wider distribution. Few railroad practices have been more abused or with more disastrous consequences. It is the recourse particularly of the broker or commission merchant, whose capital consists mainly of desk room or an office, and who uses the carriers' cars for warehouse and display rooms, having none of his own, peddling cars from one place to another, and selling

and reselling to others. As a rule these men are of the "marginal" class, a source of great trouble to the railroads, while the friction with traders of substance and experience is almost negligible.

The effect is twofold: the shipper uses the reconsignment privilege as a means of indefinite storage, avoiding to a considerable extent the imposition of demurrage; and as a means of preventing "breaking the market," defeating the effects of free competition. Besides its pernicious effect in tying up equipment, it entails a substantial additional cost of operation and interferes greatly with the smooth and effective working of the terminal yard. Letters must be written and answered, telegrams sent and telephones used, an average of eleven communications for each car diverted; while time is consumed in tracing, extra switching, delay to cars and trains, damage and claims through errors; an irritating and consuming source of waste.

In the yard these diversions present themselves in two classes: those which are destined to some point beyond and those which are carded to the yard with "Order and Notify," so that the intention to reconsign is apparent from the outset and made clear to all. The latter class causes less trouble since the car is shunted into a hold track, but it may be, and usually is, necessary to reswitch all the cars on this track once each day, to that extent delaying the normal work of the yard. It is the former class that is a bane of transportation. In a large intermediate terminal yard these cars will run in number from 20 to 25 a day. Occasionally they have to be cut out after a train is made up and has been set on the advance tracks ready for dispatching. There is nothing so calculated "to shake the nerve" of a yardmaster as to have to tear down a train that he had reason to believe he was rid of. Either he will have to put the yard crew back on the train to shift the reconsigned cars out, or have the shunting done by the road crew, with, in either case, extra cost, and the loss of precious time.

A very large number of cars are subjected to detention from these causes in large distributing terminal yards, ac-

counting for 3 per cent of the life of all cars, amounting, on the basis of those in existence on March 1, 1920, to 71,819 cars.

Looking over the yard records it would seem hard to justify the privilege. The bulk of the reconsigned cars are not loaded, as one might suppose, with perishable fruits and vegetables but, surprising as it may seem, with coal, lumber, coke, minerals, feed, wire, and pretty much everything that cannot be justified. And then the delay is itself excessive. The average time for holding a reconsignment order before the final definitive order is given is five days.

Are such privileges necessary? Generally, no, for the shipper should make all arrangements before starting a car toward its final disposition and delivery. No free reconsignments, stops in transit, or reshipments should be made, except for perishable fruits and vegetables. Backhauls and out-of-line hauls, when involved, should be made at full local rates. A charge should be made for holding cars at destinations for further orders and this without disturbance of the demurrage charge. Tariffs should provide that the notice of arrival at point of destination or stoppage shall constitute the notification, and full time under demurrage should be computed from the first 7 A.M. thereafter. Nor should cars be considered released until forwarding instructions are actually received by the local agent holding the car for disposition; not, as now, from the time filed with a distant railroad representative.

When exceptions are made and reconsignments provided for, charges commensurate with the value of the service, designed to cover something more than its cost and to prevent the defeat of demurrage and other regulations, should be made. Few things would do more to clear up transportation conditions than the rigid curtailment and substantial abandonment of the reconsignment privilege.

Of a quite different character are the "milling in transit," "fabrication in transit," etc., privileges. The effect of these is to give to the industry the advantage of the through rate instead of placing it at the disadvantage

of being subjected to the "sum of the locals." It has done much to stabilize industrial location, but the railroads should be compensated for the additional service in a rate surcharge or by switching allowance.

153. "To Order" Bills of Lading.—Bills of lading are issued by the carriers for the purpose: (*a*) of furnishing the shipper with a receipt for the goods; (*b*) as evidence of the obligation to carry the goods to destination; and (*c*) as an agreement to deliver goods to the consignee at destination upon the surrender of bill of lading properly endorsed.

Among the varieties of these bills is one known as the "to order" bill of lading. In all cases under this practice the shipper bills the shipment to himself as consignee. In some cases the party to whom it is anticipated delivery will eventually be made is named in the bill of lading with instructions "to notify." Owing to the great distance over which shipments are made, precluding close personal knowledge as to the financial situation of the parties at interest, and owing to the sparse settlement of the country and to a poor banking system, these "to order" bills of lading serve the double purpose of a transportation instrument and a commercial instrument, and the banking interests have steadily pressed for legislative action that would create, define, and augment the responsibility of the railroad company, both as insurers and as warehousemen.

These bills impose upon the railroads an additional service that is a very real burden. They assume additional liability at destination for the value of the lading in case delivery is made before the bill of lading is surrendered. They are put to the cost of switching these cars to the "hold" tracks and storing them until the surrender of the bill of lading, and to the cost of switching them out of the "hold" tracks and returning them to the current of traffic for delivery, meantime carrying the insurance. This service interrupts and greatly slows up the traffic and keeps a large number of cars out of service and is one of the really great abuses of the transportation business.

The "to order" bill of lading has been a vehicle under

which very great frauds from time to time have been perpetrated, the most conspicuous perhaps being those connected with the export cotton movement in the South Atlantic States in 1910, the bankers then estimating that more than $10,000,000 had been lost between 1908 and 1911 through advances made by them on fraudulent bills of lading.

Another example of extreme abuse was the shipment of material to the Allied Powers during the World War and the delivery made at the water-side, regardless of the fact that no shipping was available. On July 24, 1917, there were held for overseas at eastern ports 1,006,296 tons that had been unloaded on the ground and 104,934 tons still remaining on cars, or a total of 1,171,230 tons; and on November 28 of that year there were stored on the ground and in cars at North Atlantic ports 1,335,000 tons of steel and iron in addition to other commodities. Relief was obtained through the organization, on December 3, 1917, of an Allied Traffic Executive Committee, to handle both the land and overseas transportation to France, Italy, Russia, and England, with Captain Connop Guthrie of the British Ministry of Shipping acting as chairman. This Committee coöperated daily with the export division of the General Operating Committee of the railroads in the Eastern traffic region, both committees having offices at 165 Broadway, New York, and no shipments could be loaded until permits were obtained from this central body.

Almost all classes of commodities are moved under "to order" bills of lading, automobiles, lumber, wood-pulp, soda-ash, rail-plates, pig iron, salt, coke, oats, flour, peaches, potatoes, etc. In many cases the shipments are made by persons without capital whose only basis of credit is the commodity itself. The shippers using the privilege divide roughly into four classes:

1. Those who are opposed to any material change or curtailment.
2. Those who use the privilege but furnish a bond under which the traffic is permitted to move directly to final delivery. These

are in the main large shippers, such as the packers, and the bonding avoids interruption and delay in movement.
3. Those who use the privilege but agree that if necessary they can get along without it.
4. Those receivers of freight who are directly opposed to continuance of the privilege, because of its adverse effect upon their interests. These are principally the "marginal traders."

The temptation to realize on sales of commodities through the agency of the bill of lading is so great that shippers load grain, cotton, and other articles freely, in the full knowledge that they cannot be promptly unloaded at destination, because the moment the bill of lading is received they can go to the bank and get their money on the shipment. This leads at times to great delays in the case of cars so loaded. A check on the New England situation recently showed an average delay of 9 days, one car 51 days, numerous instances over 30 days. These delays are due to shortage of funds on the part of the consignees, the circuitous movement of the bill of lading through the hands of three or more banks, and delays incident to the credit operations of the banks. Questions are often raised as to the quality and character of the goods. Frequently the consignee cannot be found; in others the bill of lading cannot be located.

While almost all commodities are at times so handled, those habitually moved on "to order" bills are grain and grain products 85 per cent, hay and cotton 90 per cent, automobiles 95 per cent, and very much of the perishable freight. The use of the order bill of lading covering carloads should at least be confined to shipments of goods which the consignee is required to pay for before obtaining them from the carrier, or, expressed in a different way, where goods are sold subject to sight or arrival draft with bill of lading attached. Some shippers use the order bill of lading for the purpose of retaining control of the goods until they are ready for delivery to the consignee or to the notified party. Again, shippers will consign goods to their own order at destination and endorse the bill of lading

to a consignee who may fail to notify the carrier that upon the arrival the car should be delivered to him. Such cars are unnecessarily delayed at destination.

If a shipper desires to retain title to the goods, it is not necessary for him to consign them to his own order, but merely to consign them to himself in care of the consignee to whom he wishes them delivered. If, for any reason, he does not wish to show the consignee in the bill of lading, he should merely consign the goods to himself and promptly notify the consignee how the car is consigned and send him the bill of lading.

The practice of consigning goods to order, even where there is no banking transaction, is an old one. In many cases the shipping clerk has merely followed precedent without knowing why. This practice should be discontinued and shipments should be consigned to the order of the shipper only in cases in which it is the intention to use the bill of lading as collateral or for collection purposes.

The carriers should be assisted by the traders in getting rid of improper practices, particularly when such changes will result not only in elimination or reduction of car delay, but in better service to the traders.

1. In view of the fact that when a car moves under a "to order" bill of lading delivery cannot be made except upon the production of the bill, the delivering carrier should be allowed to make fair charge for the value of the additional service, to be added to the freight charge.

2. For the purpose of discouraging their use where they are not essential to the commercial transaction and to insure the prompt production of the bill and the prompt acceptance of the goods, progressive demurrage might be imposed, or a penalty charge made on cars held in excess of the free time allowed. This latter method was tried and found to work fairly well in the fall of 1920 on cars loaded with lumber and held for reconsignment.

3. Neither charging the consignee for the service rendered nor instituting progressive demurrage will necessarily relieve the congestion in the case of dispute or a

shortage of funds, and there should be a third remedy by which the railroad company, after a given number of days, should be allowed to unload the cars and store the goods at the risk and expense of the shipper or consignee, under proper safeguards.

4. The use of these bills of lading should be greatly restricted, eliminating a large number of commodities now moved under them, and, where practicable, shippers should be required to furnish bonds to enable direct movement to final delivery.

154. The Transportation of Explosives and Other Dangerous Articles.—Moved by the experience of the Civil War, a statute was passed by Congress in 1866 to regulate the packing of explosives for transportation, and many states enacted legislation along similar lines. The regulations prescribed were very general in scope, impracticable of application, and not really conducive to safe transportation. As the law did not provide definite rules and regulations there was a lack of uniformity in the instructions issued by the railroads. The manufacturers did not willingly comply with the rulings, through fear that their competitors on other roads might avoid the expense of a more careful preparation of their shipments and thus secure a trade advantage.

For many years the railroads struggled by individual effort to decrease the danger of fires and explosions on railroad property. The Pennsylvania Railroad had more concerns located on its line manufacturing explosives than any other railroad, and necessarily gave the matter considerable study. On February 1, 1888, they issued a general notice which quite clearly defined the method of packing and loading such shipments; they also required a certificate from the shipper describing the contents of packages and providing for proper inspection and placarding of cars. The regulations were promptly adopted by many other roads. The individual efforts of the railroads had not prevented many serious disasters, and, while the regulations were the best yet devised, it was apparent that an exhaustive survey

of the whole field and concerted action by all railroads was necessary to bring about the desired results.

In April, 1905, James McCrea, then vice-president of the Pennsylvania Lines West, with vivid recollections of several disastrous explosions which had killed a dozen or more persons and cost his company several hundred thousand dollars, advocated before the American Railway Association the appointment of a committee to prepare regulations to promote the safe transportation of explosives.

Mr. McCrea secured the appointment of a Committee on Explosives and Other Dangerous Articles to prepare and present to the American Railway Association at its meeting in October, 1905, a set of regulations for the transportation of explosives, in order that after approval by the Association these regulations might be recommended to its members for individual adoption and enforcement. While the personnel of the committee was still under consideration, one of the most disastrous explosions that had occurred in the United States happened at Harrisburg, Pa., on May 11, 1905, when 20 lives were lost and the financial loss exceeded $600,000.

The committee worked diligently during the summer of 1905. A circular was issued to all member roads of the Association asking what, if any, rules or regulations were in effect, and requesting suggestions that would tend to improve the method of handling and transporting explosives. Inquiries were sent to officials of every state in the Union asking for copies of laws upon the statute books, and to officials of every city of over 100,000 inhabitants requesting copies of their ordinances; letters were also addressed to all known manufacturers of explosives, and a hearing arranged at which views were freely expressed. At the request of the chairman of the committee, the Secretary of War designated Major B. W. Dunn, U. S. A., and the Secretary of the Navy designated Captain A. R. Condon, U. S. N., as experts to coöperate with the committee and give it the benefit of their advice and experience.

Valuable information and advice was obtained by the committee from these several sources, and rules and regu-

lations were prepared. The rules classified the different kinds of explosives in groups, stating what explosives would be accepted for transportation, how same should be packed, marked, and handled; provided a weight limit for certain explosives; and promulgated rules for the selection, preparation, and placarding of cars, etc.

The rules and regulations were presented to the Association for approval at its meeting of September 21, 1905, approved in October, and adopted promptly thereafter by practically all of its members. The uniform adoption and publication of the regulations, essential as it was, did not produce any marked change in handling explosives. Pressure was exerted by one road or another to nullify the regulations on the ground that traffic was being diverted to roads where the rules were not strictly enforced.

Before the Association met a year later it was recognized that the regulations were not being strictly observed, and the committee recommended the organization of a Bureau for the Safe Transportation of Explosives and Other Dangerous Articles, under the auspices of the American Railway Association, whose agents should educate and inspect for all members. Mr. McCrea felt it also advisable to prepare a bill for presentation to Congress, providing a penalty for failure to comply with the rules.

The Bureau for the Safe Transportation of Explosives and Other Dangerous Articles was organized during the latter part of the year 1906, and seven months later practical work was started with the election of Major B. W. Dunn as chief inspector with offices in New York City. The constitution and by-laws provided, by a general scheme, for dividing the work among: (1) a directing headquarters of the Bureau, the office of chief inspector; (2) a chemical laboratory with the necessary personnel, testing, and analytical apparatus; (3) a force of traveling local inspectors. At that time the membership comprised 78 companies, operating 136,026 miles.

An Act was passed by Congress on May 30, 1908, entitled, "An Act to Promote the Safe Transportation in Interstate

Commerce of Explosives and Other Dangerous Articles and to Provide Penalties for its Violation," repealing the statute passed by Congress in 1866 and requiring the Interstate Commerce Commission to formulate regulations for the safe transportation of explosives. During the interval from June, 1907, to June, 1908, the Bureau of Explosives, in coöperation with the manufacturers of explosives, improved the regulations that had been adopted by the American Railway Association and was in a position, therefore, to submit to the Interstate Commerce Commission a set of regulations for its consideration. These were adopted by the Commission with but few changes, taking effect October 1, 1908.

The act of May 30, 1908, was repealed March 4, 1909, by section 341 of an act entitled, "An Act to Codify, Revise, and Amend the Penal Laws of the United States," to become effective January 1, 1910. The act covered the transportation of explosives and other dangerous articles; it required the Interstate Commerce Commission to formulate regulations for the safe transportation of explosives, but did not specifically authorize the Commission to prescribe regulations for the transportation of dangerous articles other than explosives. However, the close relationship of the one group to the other and the belief of the Interstate Commerce Commission that it had power to prescribe for the carriers such regulations as were appropriate in the interests of reasonable safety, prompted the Commission to formulate the regulations for the transportation of dangerous articles other than explosives, which were published and made effective on October 1, 1911. The power of the Commission has not been challenged and the regulations have been generally observed by the shippers, although some accidents and substantial losses have been caused by failure of a comparatively small number of shippers to meet the requirements of the rules.

The act of March 4, 1909, has now been amended by an act of March 4, 1921, providing, in part, a penalty for noncompliance with the regulations for the safe transportation

of dangerous articles other than explosives, so that, at the present time, penal provisions are provided for failure to comply with the rules and regulations prescribed for the transportation of explosives and, also, dangerous articles other than explosives. The present act further provides that the Interstate Commerce Commission may utilize the services of the Bureau of Explosives in the execution of the act.

FIG. 45.—WORK OF BUREAU OF EXPLOSIVES

(1918–1920)

	1918	1919	1920
Total number railroads members of bureau December 31	430	439	449
Total mileage of bureau lines December 31	282,874	284,522	284,655
Total steamship lines members December 31	10	10	8
Total express companies members December 31	4	4	4
Total associate members December 31	73	76	83
Total inspections of stations	6,740	6,504	6,140
Number stations inspected two or more times	[illegible],039	648	791
Number of inspections of factories	201	188	167
Number of factories inspected two or more times	30	3	4
Total inspections of storage magazines	1,012	852	1,046
Number magazines inspected two or more times	43	6	26
Total boxes high explosives condemned	2,971	3,206	2,239
Total kegs black powder condemned	194	117	142
Total cars inspected in transit	665	654	631
Total express inspections	1,861	1,056	878
Total inspections steamship piers	27	25	10
Total yard inspections	228	310	327
Total inspections tank car loading racks	....	....	498
Total routine inspections made by bureau	10,734	9,589	10311[1]
Total lectures to railroad officials and employees and meetings, addressed on subject	169	290	247

[1] Including inspections by Test and Specification Department.

The information shown in Figure 45 was taken from the annual report of the chief inspector of the Bureau of Explosives for the year ending December 31, 1920, and gives in condensed form the work of the Bureau and the results accomplished during the past three years. Figure 46 compiled by the Bureau shows the number of accidents, persons

injured and killed, and known property losses from the date of the organization of the Bureau (1907) to the present year.

In comparison it is well to note that during the year 1907, the year the Bureau of Explosives was organized, 79 accidents in the transportation of explosives resulted in 52 deaths, 80 personal injuries, and a total known property loss of nearly $500,000. It is deduced from careful estimates that at all times during the busy months of the year 1918 there were on the tracks of the railroads in the United States not less than 55,000 cars of an average weight of 40,000 pounds each, bearing the placard "Explosives." Notwithstanding the tremendous increase in the volume of these explosives transported during that year, the casualties resulting therefrom were only 1 person killed, 4 injured, and the damage to property was about $33,000.

FIG. 46.—ACCIDENT AND PROPERTY LOSSES

(1907–1920)

Year	Number of Accidents	Number of Persons Injured	Number of Persons Killed	Total Known Property Loss
1920	11	12	1	$32,660
1919	10	2	2	53,220
1918	11	4	1	33,238
1917	5	1	..	9,590
1916	17	107 [1]	5 [1]	20,013,459 [1, 2]
1915	11	6	..	127
1914	11	7	..	14,106
1913	11	4	..	22,048
1912	9	6	..	10,200
1911	10	5	1	34,761
1910	16	1	2	43,636
1909	12	7	6	2,673
1908	22	53	26	114,629
1907	79	80	52	496,820

[1] Includes loss from Black Tom explosion, New York Harbor, which was a war outrage.
[2] Latest figures.

The remarkable success in transporting explosives is attributed to the efficient work of the Bureau of Explosives under the direction of Chief Inspector Colonel B. W. Dunn,

supported by the penal provisions of the law. At the present time the Bureau membership comprises 452 railroad companies operating 284,835 miles, 8 steamship companies, 4 express companies, and 83 manufacturers of explosives. The personnel of the Bureau consists of the chief inspector and office force, 32 inspectors, 1 special agent, 1 chemist, 2 assistant chemists, and 1 laboratory assistant.

The bureau is well organized and equipped to take care efficiently of the important matter of transporting explosives and other dangerous articles, and properly to meet new conditions as they arise, to the end that safe transportation may be insured from the standpoint of the carrier and its employees, the shipper, the passenger, and the general public.

155. Collection and Delivery.—For more than a hundred years preceding the advent of the railroads, merchandise was carried by canal boats, stage-wagons, cars and vans between London and the larger towns such as Birmingham, Manchester and Liverpool. A regular organized service of cartage was run on the highways at respectable speed, handling small parcels and more valuable freight. The cartage companies were as well known and as popular as the old stagecoach lines.

When the English railroads began operation they generally bought interests in these companies, relieving them of the road haul but depending on them for the terminal collection and delivery of freight. Subsequently they generally bought up the outstanding shares and now operate them as subsidiaries. Thus they maintain two general structures of rates—a "station to station" rate covering much the same service as our carload or team track service, and a "collection and delivery" rate, confined largely to L.C.L. business and in which the shipments are picked up at the store door of the shipper and delivered at the store door of the consignee.

It makes for a very prompt movement, especially at the delivering end, and minimizes the station facilities to be provided, as the same platform can be used in both direc-

tions. Before the war the costs had so increased that the service was not remunerative and the roads were contemplating increases in the charges.

Store delivery of certain classes of property was maintained by carriers in many parts of this country, but has now entirely ceased as a free operation.[1] The most conspicuous development in this service was at Baltimore and Washington. The P. B. & W. R. R., now a part of the Pennsylvania system, and then the only rail line between Philadelphia and Baltimore, introduced it at Baltimore in 1867 during the régime of General Freight Agent John S. Wilson. It was instituted by the B. & O. R. R. at Baltimore and Washington in 1886, in order to relieve congestion at the freight terminals, and also to meet competition with the water lines, particularly the Ericson Line between Philadelphia and Baltimore, and the Merchants' and Miners' Transportation Company between New England and Baltimore. The practice was confined to certain classes of shipments originating in the territory along the Atlantic seaboard, and north of Wilmington, the reason being that at that time most of the supplies and manufactured articles used at Baltimore and Washington came from the North Atlantic States. Shipments from the west and south, however, never were accorded this privilege.

The service was presumed to cover the transportation of articles falling within the first four classes, but numerous exceptions, such as household goods, plate glass, etc., were not included in this delivery. In consequence of the rapid and continuous growth of the city of Washington, this service caused considerable trouble between the carriers and their patrons owing to the increasing cost of the deliveries, The area of the free delivery was originally intended to

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[1] The principle involved was approved by the United States Supreme Court in the case of Stone *v.* Detroit, Grand Haven & Milwaukee Ry. Co., 167 U. S. 633, the court reversing a decision of the Interstate Commerce Commission (3 I. C. C. Rep. 613) to the effect that such a collection and delivery service at Grand Rapids was discriminatory. The Commission's decision had to do only with the *application* of the principle at that point.

cover the old city of Washington, but later included Georgetown, and on complaint it was ordered to include other points in the city of Washington, and also Anacostia. Attempts were then made by the carriers to withdraw this service at Washington, and upon complaint being submitted to the Interstate Commerce Commission it was held that it must be continued at that point so long as it was in effect at Baltimore. It was then withdrawn at both points on September 1, 1913.

The difficulties encountered in addition to the increasing cost were very much the same as those encountered by drayage concerns at the present time, such as delivery of packages in high buildings or deep basements, and the confusion arising from the delivery to concerns having warehouses in different localities. The time of making the delivery also caused friction, and in many cases patrons desired notice of the arrival of their goods before delivery was actually made.

During the period of the World War there occurred terrific congestions in and about the New York Terminals, and Commissioner Harlan made a careful study of the subject and recommended a store door delivery to relieve the congestion. The Armistice, however, ended the project.

John F. Stevens, a prominent engineer, worked out an elaborate plan for New York City, based chiefly on the London system. It contemplated a great joint freight depot in the Jersey Meadows, a tunnel for trucks under the Hudson, and district stations throughout the city, all to be under the supervision of the railroads. The scheme was abandoned, however, through fear it would not be permitted to make proper charges for the extra service, and that it might be held a violation of the Sherman Act.

There is still a semblance of store door delivery in effect in New York, Chicago, Philadelphia, Boston, etc., in which transfer companies are given orders on carriers for all freight consigned to certain consignees but the weakness of this arrangement is very conspicuous when it is noted that two large business houses, side by side, have different dray-

men in their employ, and the service makes no attempt to cover the delivery of promiscuous shipments to small dealers.

In Canada store door delivery has long been in force, particularly in the large distributing centers where the present system was adopted for the purpose of keeping the freight sheds clear of in- and outbound freight. For years the carriers included the cartage in the freight rates; when an increased cost of 1¼ cents per hundred weight had to be added to the carting charges the carrier absorbed it. Upon further advance in cost of delivery the carriers refused to absorb the increases and issued definite cartage rates which are paid to the carting companies as agents for the carriers. These rates are now 3½ cents to 5 cents per hundred weight, and about 60 fragile or bulky commodities are not included. It is not obligatory to use the service, and the patron has the right to do his own carting.

A method now being tried out on a considerable scale is the provision of "containers" in which L.C.L. freight is packed for trucking to the freight station, loaded and moved to destination on platform cars containing, say, four containers, two holding 3500 pounds each, and two holding 7000 pounds each, the containers with their freight being then delivered to the consignees. The movement, if successful, will be undertaken by collection and delivery companies who will own the containers and provide the trucks. One of the companies now urging such a scheme, which would involve the unloading and loading of the containers by crane or other machinery, emphasizes the statement that "a machine has no nerves, does not tire, loaf nor sabotage, does not steal, does not strike, does not demand an Adamson Law nor a Plumb Plan." The points favoring the use of containers would seem to be a saving of platform handling at the freight house, elimination of crating, minimizing of damage from rough handling, elimination of theft and the advantages of the collection and delivery system. The difficulties would seem to be the "familiar difficulty at the store delivery," the expense of provision for handling the con-

tainers, the necessity of accepting "shipper's load and count" in determining freight charges, the difficulty of collection of freight charges, and the very considerable number of articles that are too long to load cross-wise of the car or truck, and so too long to be placed in containers.

Robert Stephenson, testifying before a Parliamentary Committee August 6, 1845, said the "loose box system" had been tried over and over again and had failed, and gave a number of instances on various lines.

156. Demurrage.—Any discussion of demurrage should be preceded by some reference to the historical meaning and application of the term. The idea of demurrage appears to have had its origin in connection with maritime law and water transportation. One who chartered a vessel and failed to provide a cargo within a specified time was obliged to pay demurrage. In some of the earlier cases in the courts brought by the railroads to collect demurrage it was common for shippers to plead that the right of demurrage, if it exists as a legal right, is confined to the maritime law and only exists as to carriers by water. This view has been rejected by the courts in recent times (Miller vs. Ga. Ry., 88 Ga., 563; Galt Lumber Co. vs. A. T. & S. F., 130 Pac., 291; and Docket 83 and 83-A, 25 I. C. C., 314). In applying the demurrage principle to railroads it has been held by the Interstate Commerce Commission and the courts to be in part compensation to the carrier for use of cars and tracks, and in part a penalty to force the release of the equipment in the public interest.

Demurrage, as a cure for car detention, was applied in England where, however, it was largely used as a means to compel the using carrier to return a car to the line of the owning carrier and was administered through a clearing house which acted for all the carriers, long before it was tried in America.

Previous to 1888 no systematic method of applying a charge for the detention of a car by the shipper beyond a reasonable period for its loading or unloading was employed. On November 1 of that year, in Chicago, following out action

taken by the General Time Convention, the first Car Service Association was organized to bring about uniform nationwide practice.

A charge of one dollar per day for each car was agreed upon and demurrage associations were rapidly organized in all the large industrial centers. Much litigation ensued but, as previously stated, the validity of the charges was upheld by the Courts, and while these associations have long since passed away, the imposition of "demurrage" charges, as they are now called, is universal.

There was no uniform set of demurrage rules until the year 1909, when rules were adopted largely as a result of the efforts of a committee of the National Association of Railway Commissioners, and approved by the Interstate Commerce Commission and by practically all the state regulating commissions. They were later published in the tariffs of all of the important railroads of the United States. Demurrage matters are now handled very largely through the meetings between the Department of Demurrage Supervision of the American Railway Association, representing railroads, and the National Industrial Traffic League, representing shippers, and reference of their recommendations to the Interstate Commerce Commission for approval.

Demurrage is primarily a penalty, and was so regarded at the outset. It is not referred to as such in the act to regulate commerce. But the Commission has taken jurisdiction over demurrage, apparently upon the ground that it represents compensation for the use of the car.

The Interstate Commerce Commission has often expressed the view that the business of a railroad is transportation, not storage; and that storage at destination is a service not embraced in the rate and for which additional compensation may be exacted (14 I. C. C., 178; and 40 I. C. C., 408). This point is important in the consideration of demurrage. Many shippers make the fundamental mistake of assuming that they have an inherent right to hold freight in cars. This is wrong. They are entitled to a reasonable time within which to load and

unload freight, and that is all. If they do not unload freight within a reasonable time the carriers can exact a charge, or can unload the freight themselves and charge the expense thereof against the shipper. Carriers themselves do not seem fully to appreciate that it is their right under common law principles to unload cars when the shippers will not do so. In fact in many cases it would be more in the public interest if the carriers exercised this right than to exercise the right to impose demurrage, because, during periods of car shortage, what the public needs is cars, and no real purpose is served in such circumstances by the imposition of demurrage that does not release the cars.

As stated, demurrage is a charge separate and distinct from the line-haul charge. For this reason, it is controlled by the rate in effect at the time it accrues, and not at the time the transportation transaction began, as are freight rates. Demurrage has one peculiar characteristic: namely, it is about the only charge imposed by the publication of tariffs under the law which can be avoided; avoided by the simple exercise of diligence upon the part of the shipper. On the other hand, there is no charge imposed by railroads which seems so objectionable to shippers. In answer to the question "What is demurrage?" the applicant in a civil service examination said, "It is endless strife."

The idea of demurrage has been extended in recent times by railroads, with the sanction of the Commission, to what is called track storage charges. Track storage is imposed at large terminals, where track space is scarce and much needed.

Demurrage is not assessed on all cars, the code excepts from demurrage private cars standing on the tracks of their owners, cars placed for loading live stock, and cars placed for loading coal and coke at mines or mine sidings. In the case of live stock and coal, it has not been found necessary to impose demurrage. Coal cars are usually distributed at mines under what are known as car distribution rules. If the mines do not use the cars assigned to them on a given day, the cars are charged against their allot-

ment and this has the same effect upon the mine as a demurrage charge.

As has already been stated, demurrage is the occasion of much controversy. More complaints are received by the Interstate Commerce Commission concerning demurrage than concerning any other charge. This is due to the fact that individual traders dislike to pay demurrage, and to the further fact that many misunderstand the principles upon which it is imposed. The purpose of demurrage, broadly stated, is to bring about the free interchange and use of cars; in other words, to increase car efficiency. It is more important that the public have the general use of cars than it is that a particular trader be relieved of paying what may seem to him a high demurrage charge for their detention.

Many state laws impose upon the carriers what is known as reciprocal demurrage for failure to furnish cars. In C. R. I. & P. *v.* Hardwick Elevator Co., 226 U. S., 246, the Supreme Court had before it the Minnesota Reciprocal Law which made the carrier liable to the shipper for failure to furnish cars and held that since the Hepburn Amendment to the Act to Regulate Commerce (1906) it is beyond the power of the state to regulate the delivery of cars for interstate commerce by means of reciprocal demurrage.

It is a significant example of the difficulty of "organizing" business enterprises for common action that the early Car Service Associations, so well adapted to the work undertaken by them, work so vital to the interests of the carriers, should not have been able to maintain themselves in their field of activity. They were looked upon even by the Interstate Commerce Commission with an indulgent eye, and Commissioner Lane said in 1909, while acting as a member of the Demurrage Committee of the National Association of Railway Commissioners, "we cannot but look with disfavor upon the abolition of these demurrage bureaus, which has been partially effected in the Eastern States."

The idea was, however, not to perish entirely, and several demurrage bureaus or commissions covering restricted traffic territories persisted, united in a central organization—

"The American Organization of Demurrage Officers." They conduct their work along three different lines, as follows:

The old style bureaus continue generally to discharge the functions of the car service commissions; that is, they handle all the details of demurrage, supervising the application of the rules by the station employees, make proper inspection, compile statistics and adjust claims and disputes. Such are the Pacific Car Demurrage Bureau, the Intermountain Demurrage Bureau, and the Southeastern Demurrage and Storage Bureau.

Another type of bureau has inspectors traveling over the territory covered with a view to securing uniform application of the demurrage rules, but does nothing in the matter of adjustment of demurrage claims and disputes. Such is the Western Demurrage and Storage Bureau of Chicago. Still another type acts as an arbitration board to dispose of disputed demurrage cases referred to it either by the railroad involved or by the shipper or consignee. They have no inspection force and are not charged with any supervising duties. Such is the New England Demurrage Commission.

It will be seen that only the Pacific Car Demurrage Bureau, Intermountain Demurrage Bureau, and Southeastern Demurrage and Storage Bureau perpetuate the practice developed by the old Car Service Associations. The Pacific Bureau particularly, over a long period of years, 1908–1920, has been splendidly officered, vigorously administered, and its records kept in fine shape to reflect its experience.

It seems improbable that there has ever been a car shortage in this country in the sense that there were not enough cars to do the business. Indeed, the indications are that we have maintained a stock of freight cars at least 15 per cent in excess of any economic justification. Through abuse of equipment there is at times a deficiency of empty cars available for loading. Until this abuse is corrected such occasions will always recur. The overtime of cars held in October when they are most needed is nine times that of February. Why should a road tie up capital, incur depreciation charges,

interest, taxation, upkeep, cost of storage, to supply sufficient equipment to carry the peak load for six weeks in the year; to stand idle or, still worse, to be moved about from place to place to be kept out of the way, for the remaining 46 weeks? The remedies are fairly well known and one of them is the quick release of equipment held for loading as well as for unloading.

The present rate of two dollars per day is the cheapest storage of any character in our land, covering as it does warehousing and insurance. As a result, cars are being used as display rooms and storage warehouses instead of exclusively for transportation. They were built and capital invested in them for that purpose for which others in the community need them. Another method of abuse is the use of cars by shippers for their own interior plant movement; as an example, the transfer of steel billets from the furnace to the wire mill, and of wire from the wire mill to the nail mill; and the use of cars for the disposition of offal such as cinders, slag, rubbish, etc. The trader should furnish himself with an adequate supply of private cars for this purpose. He should also enlarge his handling facilities, increase his warehouse capacity, install labor-saving devices, and in every way possible guard against undue car detention.

The institution in the initial stages of charges for car detention of the "average agreement," by which the charge is fixed by the average detention of all cars handled by the shipper during a month instead of by the detention of the individual car, is a discrimination in favor of the big shipper and a "nightmare" in handling demurrage. It should now be abolished and the entire service be put upon a uniform basis for the traffic region covered. As a preliminary the number of debit days on which credits may be applied under the "average agreement" should be reduced from four to two, and later the entire practice abolished.

A high demurrage rate increases the available track room at stations, prevents congestions or blockades at terminals, and adds efficiency to the switching service. Shippers

then give the matter of loading and unloading preferred attention and the high rate keeps the cars moving and secures a more equitable distribution of equipment. It is significant that under the California sliding scale rate the amounts collected for car detention averaged 37.42 cents for each car, while under the high rate of six dollars the average amount collected was but 10.43 cents for each car, a decrease of about 27 cents for each car, or 70 per cent. The explanation is that a shipper who is subject to a demurrage charge of six dollars per day will hustle to get his car unloaded, but has no such incentive when the charge is but one dollar per day. With a reduction of the demurrage rate from six dollars to three dollars per day, the car detention increased 233.78 per cent. These demurrage charges should, however, have much more elasticity than is now given them and should rise to a height sufficient to accomplish the result sought in seasons of heavy movement when the prompt release of cars is most important.

The late Mr. George Hodges, of the American Railway Association, compiled the following information for February, March, April and May, 1916, months of an extreme low use of cars:

USE OF CARS

Item	Under National Code			California
	$1 per Day, February and March	$2 per Day, April and May	Total Four Months	$4 per Day, Four Months
Cars handled	4,219,926	4,494,520	8,714,446	491,866
Cars released in 24 hours free time	2,626,986	2,900,337	5,527,323	388,803
Percentage	62.3	64.5	63.4	79.0
Cars held over free time	670,113	739,004	1,409,117	8,545
Percentage	15.9	16.4	16.2	1.74
Cars held more than 3 days over free time	182,679	186,380	369,059	858
Percentage	4.3	4.1	4.2	0.17
Demurrage accrued	$1,422,039	$1,963,830	$3,385,877	$49,128

The California demurrage rate, complained of by that Bureau at that time as too low, would, if extended over the country, have reduced the number of cars held out of service and over the free time allowed from 1,409,117 to 151,631, a decrease of 84.24 per cent, and released 1,257,486 cars for service. As a considerable number of the detained cars were held over three days, the total number released would have represented not less than 1,500,000 car days.

Unfortunately, the Director General's Order No. 7 of January 21, 1918, forced into the territory covered by this Pacific Demurrage Bureau a low demurrage rate and the "average agreement," destroying the "high demurrage rate" and "straight rules," which alone will produce maximum results. This mania for standardizing conditions over the entire country broke down the results of years of patient effort.

The effect on the car supply of prompt handling of cars by the traders is but little appreciated. A consignee who unloads a car in four days as compared with one who holds a car only six hours will require on a hundred mile average haul about two and one-half times as many cars.

What is needed now is an intelligent review of the whole situation; one method would be the creation of a number of Demurrage Bureaus similar to the Pacific Demurrage Bureau sufficient to cover the several traffic regions, with headquarters so placed as to be within 24 hours railway mail service from the most distant point in their administration.

The situation is now being taken in hand by the American Railway Association, which, on January 1, 1921, organized the Department of Demurrage Supervision for the Trunk Line and Central Freight Association territories, which is functioning efficiently. This may provide a satisfactory solution.

Why cannot the business men join the railroads in urging upon the Interstate Commerce Commission to say in effect to the main contributors to car shortage, "hereafter you will pay the cost in a high demurrage rate, or release cars

within the free time allowed, that neighboring shippers may use them for transportation purposes''?

The Manager of the Pacific Car Demurrage Bureau has recently made 63 suggestions for changing the demurrage rules and regulations, and they contain so much that should be done that I reproduce them below:

Proposed Changes in Demurrage Rules and Regulations

1. Increase demurrage rate to minimum of five dollars per car per day with an increase in rate of one dollar per day at first of each succeeding month.
2. Abolish the average agreement.
3. Restore stringent and efficient demurrage rules similar to our former tariff.
4. Reduce free time on cars for loading to 24 hours, computed from actual spotting of car.
5. Reduce free time on export freight to a minimum of ten days or a maximum of 20 days, computed from arrival at port of exit. Shipping or embargo permits to be issued by one office for all rail lines.
6. Compute time on all cars held for unloading from 8 A.M. instead of 7 A.M., as at present.
7. Reduce free time on tank cars to 24 hours.
8. Eliminate extension of free time on account of weather conditions.
9. Charge demurrage for all Sundays and holidays after expiration of free time.
10. On cars ordered and not used assess charge of ten dollars when line haul involved, and five dollars when moved from a point within switching limits.
11. Provide for collection of demurrage when dunnage or rubbish is not removed from cars.
12. Provide for collection of demurrage when carrier is prevented by causes beyond its control from removing cars from industrial plants after release.
13. Reduce free time on all cars and commodities to 24 hours in the event foregoing changes do not produce desired car conservation.

Furnishing Notices of Arrival of Cars

14. Give telephone notice of arrival on all cars received as quickly as possible, and confirm by postal card.

15. Whenever possible, mail postal card notices of arrival 24 hours of the day, seven days of the week.
16. Give advance notice to consignees of carload freight to enable them to take delivery immediately on arrival.
17. Encourage grain and produce dealers to establish clearing offices for purpose of receiving arrival notices and to give disposition of carload freight.

Car Distribution

18. Censor car orders at time given to prevent misuse of cars.
19. Accept car orders only in writing.
20. Place identification tags on all cars for loading to prevent misappropriation of empties.
21. Do not assign cars to any particular service unless kept fully employed at all times.
22. Give preference when possible to those who will load them promptly and heavily.
23. Eliminate use of cars for cross-town hauling except where absolutely necessary.
24. Employ competent, well-paid car distributors and assistants with full authority to make proper distribution and prevent misuse of equipment, eliminate cross-hauls and follow up delayed loads.

Demurrage Bureaus

25. Reëstablish efficient demurrage bureaus throughout the United States.
26. Demurrage bureaus should publish monthly figures on car detention caused by cars being held for prospective loading, delays in spotting cars for unloading or pulling cars after released, or any other railroad delay.
27. To assist the Interstate Commerce Commission in arriving at remedial demurrage regulations, demurrage bureaus should publish statistics for each station monthly, showing cars released before free time began, in first and second day of free time, as well as cars under demurrage and the length of detention, charges and disposition of the same.

Terminal Charges

28. Reconsignment rules to be reconstructed, exceptions omitted and enforcement placed in hands of demurrage bureaus.
29. Provide charge of ten dollars on every car set out, held and picked up for inspection and grading of contents.
30. Provide charge of ten dollars on every car billed to shipper's order, notify.

31. Provide spotting charge of five dollars for cars constructively placed or held on account of consignee being unable to receive them.
32. Provide charge of one dollar per day on all tank and other private cars stored on carrier's rails.

Train and Yard Movement

33. Prevail on shippers to have cars ready to move and billing in hands of agents in time to move forward by first switch or train service.
34. Classify cars when placed in trains with regard to station, track and industry destination to save switching at terminals, avoid congestion and "bottling up" of yards.
35. Put on extra trains, when necessary, to move cars set out at sidings to reduce tonnage or for bad order.
36. Reduce tonnage of trains so they can get over the road without breakdown in power.
37. Standardize time and number of switches to be given daily by yard engines.
38. Use switch foreman's work list as a check on work performed and to show time cars are spotted and time pulled from industries.
39. Have disposition slip made on every car received in yard and follow up with shipper or railroad employees religiously until car is released.
40. Install track scales at strategic points to avoid back or out of line hauls.
41. Install compressed air tube system wherever practicable to facilitate handling of waybills, car and disposition orders to expedite switching or movement of cars in trains.
42. Arrange for leasing power belonging to industries or contractors to do switching and relieve power shortage.
43. Make light repairs to cars in yard without switching to repair track.
44. Advance train clerks to work ahead of local trains to prepare their work.

Miscellaneous

45. Agents should refuse to accept bills of lading for shipments destined to (large city) terminal points unless consignees' street and telephone number are shown, and the name and number of the track on which car is to be unloaded.
46. Unload and store contents of refrigerator cars if not released within free time.

47. Terminal efficiency committees should have inspectors stationed at important stations to report fresh facts for committee's action; and sub-committees should be formed at all large terminals.
48. Restrict use of railroad telegraph wires with priority given to train movement, then to car handling and other business to follow in order of importance.
49. Impose penalty for detention of cars containing company freight and publish statistics showing departments responsible.
50. Publish statistics on delays in repairing bad order cars and follow up closely.
51. Establish joint car inspectors at interchange points to prevent disputes in application of M. C. B. rules.
52. Place all minor railroads that are common carriers on a per diem instead of a demurrage basis.
53. Encourage consignee to employ public draymen to handle team track cars, as they are the most efficient car releasers.
54. By analysis and comparison encourage consignees to enlarge facilities and install improved appliances to release cars quickly.
55. Allow agents a percentage of all net demurrage charges collected at their station.
56. Number warehouses, doors or designate spots where cars are to be placed.
57. All car orders and bills of lading should be stamped with date and time received by agent at originating point.
58. Have advance man ahead of local trains, signal maintainers or track walkers take check of cars at blind sidings to save time of local freight crews and protect demurrage.
59. All diversions, whenever practicable, to be handled through commercial telegraph lines to relieve railroad wires and insure quicker action.
60. More speed in placing embargoes at the commencement of a congestion.
61. Make special arrangements with Post Office Department to speed up delivery of post card notices of arrival of carload freight. (This plan has been followed out heretofore with great success.)
62. Encourage industries to install devices for doing their own interplant switching.
63. Paving of public delivery tracks and removal of obstructions preventing quick release of cars.

The great bulk of these suggestions are addressed to the railroads for the improvement of their practice. Nos. 33, 45, 46, 53, 54 and 62 are matters covering the conduct of shippers.

157. Private Cars.—On December 31, 1919, the railroads reported the ownership of 50,414 refrigerator cars in actual service; the Equipment Guide gives the total number privately owned as 65,000, making the total active refrigerator equipment 115,414 cars.

The Car Service Section at Washington reported a shortage of refrigerator equipment during the year 1920 of 59,547 cars. They reported in 1919 a surplus of 109,886 and in 1918 a surplus of 81,108. If the best loading practice had obtained generally, an average loading would have been secured of 15.4 tons per car, making the possible equipment loading 1,777,426 tons.

By applying the average haul of all refrigerator cars, which is 12 days per trip, or 30 trips per year, there is indicated an ability to move 53,322,768 tons per year. The reports show the total refrigerator tonnage originating on all lines as 37,787,324 tons, which would indicate that no more than 70 per cent of the available tonnage capacity was utilized. The practical available margin would appear to be as high as 45 per cent. The remedy should be sought not in additional capital investment but in increased managerial activity.

What very considerable results in movement may be obtained through the skillful handling of the car equipment is seen from consideration of the results achieved by the five packing companies. They owned 19,607 refrigerator cars in 1913, 17,658 in 1915 and 29,987 cars in 1920. The total investment in 1919 approximated $20,500,000, and at the mileage rates of about 8½ mills (three-fourths of a cent east of the Mississippi, one cent west of the River) this equipment was operated for a return of no more than one per cent.

The following statements (Figures 47 to 50, inclusive) are illuminating:

In 1894 the number of cars privately owned was about 70,000; on January 20, 1921, it was 181,050 with no definite reports from 37 companies.

The English roads in the 1880's made a systematic effort to rid themselves of private cars, claiming that their handling

necessitated a heavy expense in accounting, checking, and switching them to proper return deliveries; that they moved quite regularly empty in one direction; that they were not kept in a sufficiently good condition of repair, nor did they advance with the development in capacity or appliances. The "Midland" bought out the private owner. None of the other companies went so far and nothing came of the struggle.

Fig. 47.—Average Miles per Car per Day

	1910	1911	1912	1913	1914	1915
Armour	64	71	66	66	69	80
Cudahy	88	97	90	90	90	107
Cold Blast	77	72	66	67	65	68
Morris	80	83	75	75	76	85
Swift	67	67	67	61	51	66
Average	70	73	69	67	67	76

Fig. 48.—Cars Owned

	1910	1911	1912	1913	1914	1915	Average
Armour	6,058	6,029	6,209	6,640	6,086	5,225	6,041
Cudahy	1,314	1,383	1,406	1,489	1,462	1,442	1,416
Cold Blast	1,371	1,708	1,692	1,747	1,733	1,698	1,656
Morris	1,637	1,925	1,982	2,110	3,121	2,271	2,008
Swift	6,337	6,440	6,472	7,621	7,344	7,022	6,856
Total	16,817	17,485	17,762	19,607	18,736	17,658	17,977

The above figures bring out the following points:

With the exception of the Morris Company, the maximum number of cars for each company and the total for the five was reached in 1913.

With the exception of the Morris Company, the number of cars owned by each company and the total for the five companies was less in 1915 than 1914 and in both these years less than in 1913.

All companies, except Armour and Company, owned more equipment in 1915 than in 1910.

In this country private ownership of cars has been now encouraged, now opposed. For a time the owners of coal cars enjoyed an advantage by adding such of their cars as were available to their distributable proportion of cars owned by the railroads, but later rules of the Interstate Commerce Commission destroyed this advantage by requir-

ing that the distribution be made as though all the cars were the property of the railroad, so that they no longer enjoy any advantage in being furnished with cars and are penalized by their ownership through an entire loss of direct return on the capital investment and through the expense of maintenance. Serving a purpose in times of car shortage, the cars of these classes which are stored when out of service rapidly deteriorate in times of car surplus.

FIG. 49.—TOTAL EARNINGS AND EXPENSES OF THE FIVE COMPANIES

	Total	Per Car	Per Car Day	Per Car Mile
1910				
Earnings....	$3,843,372	$231	$0.633	$0.0091
Expenses....	3,323,924	200	0.549	0.0079
Net Earnings....	$ 518,448	$ 31	$0.084	$0.0012
1911				
Earnings....	$4,106,933	$235	$0.643	$0.0088
Expenses....	3,591,515	206	0.562	0.0077
Net Earnings....	$ 514,418	$ 29	$0.081	$0.0011
1912				
Earnings....	$4,009,169	$226	$0.618	$0.0090
Expenses....	3,623,216	205	0.561	0.0081
Net Earnings....	$ 385,953	$ 21	$0.057	$0.0009
1913				
Earnings....	$4,255,154	$217	$0.595	$0.0089
Expenses....	4,461,896	227	0.625	0.0093
Loss...........	*$ 206,742*	*$ 10*	*$0.030*	*$0.0004*
1914				
Earnings....	$3,955,772	$213	$0.583	$0.0088
Expenses....	4,304,634	230	0.629	0.0095
Loss...........	*$ 348,862*	*$ 17*	*$0.046*	*$0.0007*
1915				
Earnings....	$4,281,673	$243	$0.664	$0.0087
Expenses....	3,928,694	223	0.609	0.0080
Net Earnings....	$ 272,979	$ 20	$0.055	$0.0007

Earnings include revenues from mileage, rentals, refrigeration and other earnings.

Expenses include repairs, both home and foreign, depreciation, renewals, rentals, refrigeration, taxes, insurances, administration and other expenses.

FIG. 50.—INVESTMENT AND RETURN THEREON OF THE FIVE COMPANIES

	1910	1911	1912	1913	1914	1915
Cars	$15,151,000	$16,753,000	$17,314,000	$20,624,000	$19,600,000	$19,084,000
Other Property	767,000	747,000	857,000	898,000	809,000	831,000
Total	$15,918,000	$17,500,000	$18,171,000	$20,522,000	$20,409,000	$19,915,000
Profits	$ 518,000	$ 514,000	$ 386,000	....	....	$ 273,000
Per Cent on Investment	3.3	2.9	2.1	....	....	1.4
Less	....	....	....	$ 207,000	$ 349,000	
Per Cent on Investment	....	....	....	1.7	1.7	
Estimated Incidental Revenue from Incidental Mileage	$ 573,000	$ 711,000	$ 628,000	$ 709,000	$692,000	$ 747,000
Allowances Asked for						
Per Cent on Investment	3.6	4.1	3.5	3.5	3.5	3.7
Estimated Profit with Incidental Revenue	$ 1,091,000	$ 1,225,000	$ 1,014,000	$ 502,000	$ 343,000	$ 1,020,000
Per Cent on Investment	6.9	6.9	5.6	2.5	1.8	5.1

The figures submitted by the Packers show they lost money in 1913 and 1914, which almost offset their earnings in 1912 and 1913.

During the last six years they made $1,135,000, or an average over the six years of approximately one per cent.

The increase asked for varies from 3.5 to 4.1 per cent on their investment, which would have made these cars earn the last six years no more than an average return approximating $870,000 or 4.8 per cent on the capital investment.

158. Facilities Furnished by the Public.—In many of the large cities facilities are furnished by the public authorities under compensatory charges for the use of the railroads—belt tracks, connecting tracks, piers, wharves, waterside accommodations and other varieties of service facilities. In almost every city these facilities rapidly became inadequate both in size and in the character of service rendered.

Let us as a type consider the port of New York. The largest city in the country, it contains more manufacturing plants than Chicago, St. Louis, Cleveland and Philadelphia combined. It is difficult of access, the main city being located on an island and directly reached from the West by the freight tracks of only one road. To the normal local business of a community of eight millions of inhabitants organized in 105 municipalities, the uninterrupted movement of foodstuffs in their original or manufactured state, the raw, fabricated or finished products required by the industries, the business passing through by rail and water to and from New England, there is added about 45 per cent of the foreign commerce of the country. The waterfront of the New Jersey shore is largely owned and used by the railroads and steamship companies. On the New York shore the waterfront is largely owned by the City and the improvements thereon have been built by it and leased to the railroad and steamship companies. On the Staten Island and Brooklyn shore the facilities are privately owned, and on the latter are some wonderful storage warehouses. The volume of business is, of course, very great, fruits and vegetables alone amounting to from 85,000 to 90,000 carloads per year, running at certain seasons 700 carloads a day, and handled between eight o'clock at night and two or three o'clock in the morning in order to make the market.

About 1862, competition for business on both sides of the River between the New York Central and Erie Railroad led to the introduction of lighterage service. The export, import and coastwise steamer traffic is handled by lighters. Where freight is delivered by lighter, two handlings are necessary; where it is held on the piers, three

to four handlings are required. The lighters and barges have a capacity of from six to eight carloads of freight but carry only from four to four and one-half carloads. The round trip consumes from seven to ten days. Car-float service is used principally for handling cars to pier stations and team yards, and for transfer service in the harbor.

The great bulk of the business is inbound. To handle it the roads terminating in New Jersey mantain 150 tug boats, about 1800 barges and lighters and 300 car floats, or nearly 2300 pieces of lighterage equipment. The New York Central, New York, New Haven & Hartford, and Long Island railroads maintain 43 tug-boats, about 251 barges and lighters and 124 car floats, or about 418 pieces, a grand total for the port of 2718 pieces.

Many of the piers were planned and built nearly 45 years ago, while many of the narrow slips were intended for the old-style sailing vessel or for tramp steamers. During this time first one and then another commission has considered the terminal problems of the port. Until recently nothing had been accomplished, no plan matured or adopted, no comprehensive work undertaken. Now a scheme has been brought forward as a result of the studies of the New York-New Jersey Port and Harbor Development Commission, which has been reviewed by the Port of New York Authority appointed for this purpose, and its recommendations submitted to the Legislatures of the two States. In transmitting these recommendations to the Legislature of New York State the Governor of that State said:

> The present facilities have been developed without plan, largely as mere expedients and in such fashion as to create rather than to relieve congestion. No one disputes that they are inadequate to the prompt handling of the commerce of the port and unduly expensive. The resulting burden of expense and loss falls upon the commerce of the country, upon consumer and producer alike, for New York is the great distributing, receiving and manufacturing center. . . . The Port authority has already been constituted. The compact creating it has been unanimously approved by Congress. It is the one existing agency having the power, the capacity, the

public confidence, the necessary contacts with other agencies, municipal, state and national, and the knowledge of the problem required for the inauguration of prompt measures of relief. . . . Obviously the first thing to do is to bring about a better coördination and unification of existing facilities so as to secure a maximum of efficiency at a minimum of expense and delay. . . . The question now is whether those unrivaled advantages shall longer be handicapped by obsolete and inadequate methods and facilities.

This may appear as an extreme case, but it is repeated in varying forms in every large city in the country. The facilities for handling railroad freight transportation provided by the public may safely be described as even more meager than the plant facilities of the traders; at present they need to be increased by 75 per cent.

159. Plant Facilities.—An inventory of the car situation on August 31, 1920, on the D. & H. Company's lines, showed:

Car Situation, August 31, 1920

	Delivered	Undelivered
Empties awaiting loading	597	
Loads awaiting unloading on business sidings	956	413
Loads in yards awaiting orders	....	240
Loads stored awaiting orders	....	70
Held for billing instructions	....	97
	1553	820

This would indicate that the ratio to those delivered of the cars undelivered because of the shippers' inabilities was 53 per cent. A careful canvass of the entire line was subsequently made, and the business and facilities of each shipper studied. This confirmed the conclusion that the shippers were short by 50 per cent of the facilities necessary to enable them to handle their business with the railroad without delay to cars.

The reason for this is perhaps not far to seek. During all my term of service, the responsibility for furnishing these facilities has been a matter for dispute. Where the railroads have built the private sidings they have felt that they were imposed upon and have economized. Where the

trader has built the tracks, he has resented it as the transfer to him of a burden he feels the railroad should bear and has built as little as possible. As his business grew and expansion became necessary he avoided where possible the purchase of additional lands and often enlarged his buildings taking up part of the sidings, so that, under-supplied at the start, he later had for his increased business even less than at the beginning.

The Interstate Commerce Commission, the railway executives and the traders should authoritatively dispose of this troublesome question. With the responsibility for the installation determined, pressure could then be exerted to secure adequate provision of facilities, eliminating one of the most potent causes of irritating and costly delays.

As indicating the cumulative effect of this inability of shippers to handle their business in the general railroad movement, an analysis on the lines in the New England region from 1910 to 1915 shows that as long as the consignees' detention was normal no serious congestion was experienced, but from August, 1915, to March, 1916, when the cars subject to demurrage increased 12 per cent and the detention due to inability of the consignees to receive and unload cars, cars increased 21 per cent, the effect on the railroads was to increase the detention in their hands 170 per cent. Again, from April, 1919, until the close of that year, with an increase of 21 per cent in number of cars handled, the consignees' detention increased 21 per cent and this resulted in an increase of railroad detention of 160 per cent. This may be taken as fairly indicative of similar relations throughout the country; i.e., we may expect that when there is a prolonged inability of the consignees currently to dispose of their business, the effect is to increase the railroad detention about eight times.

160. Yard Handling.—The traffic men are prone to speak of the yards as the "graveyards" of cars and to lament when new ones are built, or old ones enlarged, and there is much to support their criticisms. We have seen that in its round trip the car is on the transfer or yard tracks 9.2

days, or 61.7 per cent of the time. I have discussed features of yard design and the facilities at interchange points that would facilitate the car movement, and directed attention to many physical obstructions that delay them, in the chapter on "Permanent Way."

I have made it a practice whenever I took on a new responsibility to make an inventory of what I was in fact making myself responsible for. In the check that I made of the cars when I went to the Baltimore & Ohio, we found one car run off the end of a siding in the Locust Point Yard that had lain there for 15 months. That was, of course, a very extreme case, but delays that seem quite incomprehensible are the daily experience.

One of the largest fields of economy lies in yard expenses. If the operations could be so organized as to require a smaller number of movements of the cars handled, and if the road movements could be so organized as to minimize the necessity of handling cars in yards, very great economies could be had.

The work of switching and classifying the traffic into trains of varying importance, into yard cuts for advanced handling and into station order for division distribution, is of immense magnitude and difficulty, and at the terminal stations and at the important intermediate yards and junction points is extremely complicated and expensive. The subject should be studied, discussed and debated to a greater extent perhaps than any other problem of operation with which railroad management has to deal. It is impossible to magnify the importance of conducting this work systematically and effectually, and with the least expenditure of time and money. The heart of the transportation business is the station work. Upon the efficiency of those who do it depends the success of the subsequent movements, of which the yard handling of the car is one. The clerical work should be carried on simultaneously with the handling of the goods, the side cards being attached to the car and the waybills completed by the time the car is ready for its journey. Care should be taken to convey the goods directly from the wagon and weigh scale to their place in

the car; to stow the goods so as to avoid damage by breaking; to load the goods, if in a way-car, with reference to their removal; and to load the car as nearly as possible to its capacity. Not only does this last help to secure the minimum train and switching mileage, but it effects economy because such increase in the load does not proportionately increase the work done by the locomotive. The cars, on being made up in trains, should be arranged in the order of the stations to which they are destined, for the time wasted in switching on the road is very great. About the fifth and twentieth day of each month the agent should make a record of each car loaded at his station, with the kind and amount of loading and with an explanation in case of an underload.

Cars should be handled methodically, to eliminate every avoidable movement or detention and to keep them in continuous motion, as near as may be, in the direction of their final destination. No car should be moved without certainty as to its destination. In cars dispatched, this may be insured by a proper use of the waybill. In cars distributed, this may be insured by a proper use of side cards. Few things are more helpful in a large terminal than the institution and enforcement of a well-devised system of side cards, sufficiently distinctive to be seen at a reasonable distance and easily memorized by all interested. One of the early systems of switching side cards originated in Indianapolis in the 80's. No one thing was so effective in relieving our crowded Cleveland terminal as the expansion and use of the system there. A comprehensive system of carding in large terminals may greatly expedite the work.

A daily check is made of all the cars in the yards at a stated hour, but too often it is regarded as perfunctory and carelessly conducted. It should be made with exactness and cars shown to be unduly detained should receive special attention from some officer charged with that duty as his chief function. The initials and numbers of cars have to be taken by yard clerks, yard trainmen and road trainmen under circumstances that are at times very trying. It is no attractive experience to go down between two long lines

of cars on a stormy night, hunt over their sides in the dim light of the lantern for the information wanted, and make the necessary record. To help this situation at least in one respect I very carefully determined the height at which the initial and number of the car could most easily be read, and got the Pennsylvania management to stencil their freight cars at that height in the lower left hand corner. Afterwards a uniform system of marking, giving permanent effect to this practice, was adopted by the American Railway Association. It is to be regretted that its importance is not generally recognized. Some better system of numbering should be devised. The car numbers, now, too frequently run absurdly and awkwardly high. For some reason the prefix numbers, that were used for the various classes of equipment and that tended to keep the numbers low, did not prove popular.

The yard office should be carefully fitted with regard to the work—racks for waybills, car cards, designed to show the location and detention of cars and indicating at a glance cars that are unduly detained, tabulating devices, stationery and every helpful appliance. Racks should be provided to hold conductors' cards in one week's or one month's collection, and a suitable yard record, the "Borner" or one similar, should be used to contain the history of each car handled.

The great weakness of the yardmaster is his absorption in the business immediately in hand and its dispatch upon the road, and his failure to reckon with what is coming, his general lack of information regarding road conditions. It is not uncommon to find a yardmaster hustling to get out a train of slow freight and using his last available road engine, only to be faced with the arrival an hour later of a quick dispatch train, which may be delayed five or six hours in consequence of lack of power. It will often be found possible by systematic and sustained effort to reduce the delays in yards by one-half. We should stand for a maximum detention of not more than five hours.

Figure 51 gives data that are kept of the movement through the yards of the Delaware and Hudson Company.

FIG. 51.—MOVEMENT OF CARS THROUGH YARDS[1]

Date	Pennsylvania Division				Susquehanna Division						Saratoga Division		Champlain Division		Weighted Average
	Wilkes-Barre	Hudson	Carbondale		Binghamton	Oneonta		Mohawk		McVille	Mohawk	Whitehall	Whitehall	Rouses Point	
	5 North	9 North	9 North	8 South	7 North	10 North	9 South	5 North	12 South	9 South	12 North	9 South	9 North	9 South	
1920															
June	*6 30*	*15 24*	*9 54*	7 30	*12 30*	*18 54*	*15 06*	*27 36*	*17 30*	*14 12*	11 54	7 00	7 36	8 24	12 54
July	*8 06*	*15 48*	*10 06*	7 12	*9 36*	*16 36*	8 18	*24 24*	*22 42*	*12 48*	*16 36*	*9 24*	*11 24*	8 54	11 42
August	*5 42*	*23 00*	*9 42*	7 42	*11 24*	*24 54*	*12 00*	*61 06*	*27 12*	*14 48*	*19 18*	7 42	*12 24*	*9 00*	14 30
September	*5 18*	*15 48*	7 00	5 36	*13 06*	*17 36*	*12 54*	*63 24*	*14 48*	*11 42*	*16 36*	7 06	*9 00*	*9 24*	11 00
October	*7 42*	*12 24*	6 54	7 24	*9 06*	*12 36*	*14 06*	*29 36*	*12 36*	*11 54*	10 48	5 48	7 12	*10 30*	10 30
November	*10 54*	*11 36*	*9 48*	7 24	*7 48*	*13 36*	*11 48*	*40 36*	*15 00*	*10 42*	*14 12*	7 30	7 24	*9 24*	10 36
December	*15 06*	*12 12*	8 12	*8 18*	*7 30*	*14 54*	*10 48*	*39 12*	*17 06*	*9 12*	8 24	*9 48*	*9 48*	*12 00*	10 48
1921															
January	*6 12*	*10 18*	7 54	*12 30*	*8 00*	*14 18*	*11 42*	*39 54*	*20 12*	*10 24*	11 12	*10 24*	8 24	*15 18*	11 42
February	*5 48*	7 54	7 48	7 36	5 24	*14 12*	*10 36*	*8 30*	*12 30*	8 54	7 06	*12 54*	6 18	7 18	9 36
March	*7 54*	8 18	*9 18*	6 54	5 18	*11 42*	*11 24*	*5 24*	*12 54*	7 06	9 06	*13 54*	*10 00*	8 18	9 30
April	*7 48*	8 42	8 54	6 24	6 12	*15 30*	*10 30*	1 12	*17 24*	7 24	*12 12*	*9 42*	8 24	5 24	9 54
May	*5 54*	8 42	7 36	*9 36*	5 18	*11 30*	6 30	.. ..	10 42	5 46	*14 54*	8 54	5 48	6 36	8 00
June	*5 06*	6 36	8 18	*8 30*	5 24	*10 00*	7 24	.. ..	*13 18*	5 18	*16 54*	3 42	6 24	6 54	7 48
July	*5 24*	5 54	8 18	6 36	5 06	*13 06*	*9 12*	.. ..	*14 12*	7 00	*13 12*	2 12	5 24	7 06	8 18
August	*5 12*	6 30	*9 36*	4 24	4 42	9 42	8 36	.. ..	6 30	7 00	*14 00*	2 54	5 06	5 12	7 18
September	3 42	5 12	*9 30*	3 06	4 42	9 42	8 48	.. ..	5 12	8 30	*13 30*	4 12	7 24	7 06	7 18
October	4 30	7 54	*10 18*	3 24	5 42	*11 42*	*9 24*	.. 48	3 30	5 18	*12 18*	4 18	8 06	6 30	7 48
November	1 06	3 12	8 36	7 06	3 48	*10 18*	8 42	.. ..	6 12	6 48	9 42	3 54	6 12	8 54	7 24
December	.. ..	6 00	*12 06*	5 54	3 30	*10 30*	8 12	.. ..	10 18	7 48	9 30	4 00	7 42	1 54	7 42
1922															
January	.. ..	3 36	*11 54*	6 06	3 36	9 48	6 30	.. ..	4 36	6 24	10 30	4 42	8 00	1 30	6 54

[1] The figures shown over each column indicate maximum average delay in hours consistent with proper operation. Italicized figures are those which exceed the maximum delay consistent with proper operation.

Statement Showing Number of Days in Each Month in which Maximum Delay Consistent with Proper Operation was Exceeded.[1]

Date	Pennsylvania Division				Susquehanna Division						Saratoga Division		Champlain Division		Per Cent of Total
	Wilkes-Barre	Hudson	Carbondale		Binghamton	Oneonta		Mohawk		McVille	Mohawk	Whitehall	Whitehall	Rouses Point	
	5 North	9 North	9 North	8 South	7 North	10 North	9 South	5 North	12 South	9 South	12 North	9 South	9 North	9 South	
1920															
June	19	24	16	9	23	28	27	27	14	27	15	11	8	14	62.4
July	22	25	16	11	24	30	14	29	25	24	23	12	20	14	66.6
August	19	31	17	12	23	31	23	31	19	25	23	12	20	15	69.4
September	18	21	5	6	20	26	21	30	18	21	18	8	12	14	56.7
October	22	23	6	11	18	22	29	31	16	23	11	5	11	16	56.2
November	25	20	15	13	15	21	25	28	16	23	15	13	12	13	60.5
December	31	25	17	16	21	29	18	26	22	12	10	17	18	20	61.3
1921															
January	20	20	12	23	19	24	23	27	22	17	13	17	14	24	63.3
February	16	13	9	7	1	22	19	8	17	15	8	23	6	9	44.1
March	25	16	16	10	2	10	18	5	17	8	9	24	17	13	45.9
April	26	15	17	8	5	25	19	2	19	4	17	16	15	8	46.7
May	20	15	9	19	2	18	10	..	18	5	21	13	9	9	38.7
June	14	11	10	16	3	14	5	..	13	4	25	4	8	10	32.6
July	15	7	12	9	2	19	16	..	14	8	18	..	7	12	32.0
August	15	8	18	3	1	16	13	..	5	7	21	2	6	9	28.6
September	6	7	15	2	..	12	12	..	7	8	23	2	10	12	27.6
October	14	18	22	2	6	22	17	1	1	6	18	3	14	10	35.5
November	4	2	11	12	2	14	12	..	5	9	13	2	6	15	25.5
December	..	13	23	5	..	15	11	..	8	12	9	1	11	1	25.1
1922															
January	..	4	18	8	..	14	6	..	5	5	11	2	12	..	19.5

161. Trap or Ferry Cars.—The term "trap" or "ferry," strictly speaking, is applied to a car placed at an industry or commercial house having a private siding, and there loaded by the shipper with less than carload shipments and hauled by the carrier to its local freight or transfer station for handling and forwarding of contents. It is also applied to a car with L. C. L. shipments which is hauled to and placed upon a private track of an industry or commercial house by a carrier from a local freight or transfer station. In the East the name "ferry" is given to a car used in this manner, and in the West and South "trap" is applied. The origin of the names is not clear but both mean the same, and for convenience the word "trap" is used

Where such cars are loaded to a minimum, the practice at the beginning was to make no charge for the service. The trap car service came to be generally rendered without separate or specific charges from several causes. In cases where no land was available for the location of an industry near the freight station, the assurance of freight car service was an inducement to an industry to locate along the line, although necessarily some distance from the freight station. Competition also played its part in the establishment and maintenance of the service. An industry located near a freight station of one road might be served by a side track connecting with another road which had no freight station in the vicinity. By the use of the trap car service the latter was enabled to compete with the former for less than carload traffic which otherwise would all have been drayed by the shipper to the nearest freight station. It was a natural step from unloading and loading carload shipments to the unloading and loading of less than carload shipments on the same siding. It was early demonstrated that one of the effects of the service was to relieve congested main freight depots and to postpone the cost of additional freight terminals. The service was also beneficial to the industry or commercial house using it.

With the passage of the Hepburn Act in 1906, the filing of tariffs to cover this service began. The character of the

service was not uniform, nor did it extend to all points. In some cases it was performed without separate or specific charge, and in others charges were made comparable with local switching charges for movements of carload shipments. These tariffs covered only the service where it already existed. In consequence the tariffs showed the same lack of uniformity that had prevailed for many years. On October 12, 1908, the Interstate Commerce Commission, in Ruling No. 97, Conference Rulings Bulletin No. 6, issued the following:

> The Commission condemns as unlawful a practice under which a carrier provides an empty car at factory sidings in which the shipper may load less-than-carload shipments which the carrier then moves to its regular freight station where the shipments are assorted and placed in other cars to be forwarded to their respective destinations. Such a practice is lawful only under definite and clear tariff authority, nondiscriminatory in terms and in its application.

Thereafter tariffs were filed which contained rules with respect to this service and there have been many complaints and rulings by the Interstate Commerce Commission covering the service. In few cities are freight station facilities adequate to handle the L. C. L. traffic which would be offered in normal times if any considerable portion of that moved in trap cars should be sent to the stations by dray. Deliveries to local stations by dray are usually made in the afternoon of each day and at all points station facilities are taxed to their utmost between two and five o'clock. Trap-car freight on the other hand usually reaches the station in the night and may be handled by the station forces before the rush period. Trap service is of advantage to its users because it saves drayage of L. C. L. shipments, permitting the loading of both carload and less-than-carload shipments from the same warehouse, and also enables the user to load or unload commodities in bad weather without risk of damage. It permits the location of an industry or warehouse at some distance from freight stations where the land is comparatively cheap, and it obviates rough handling of commodities incident to drayage. As compared with

drays, trap cars, the contents of which are rehandled at local stations, furnish a delayed service. The cars are usually placed on the sidings early in the day and are removed therefrom late that day or in the night. When shipments are drayed they ordinarily go outbound from the station the same day. The contents of the trap car, however, if sent to a local station usually do not move outward from that station until the following day, a delay of 24 hours.

The advent of the great mail order houses, and the growing desire of consumers to buy direct from producers has enormously increased less-than-carload shipments in recent years.

The amount of service rendered by different carriers, and by the same carrier at different points, varies greatly according to conditions. The service is not confined to large cities with many and varied industries, but is rendered at all points, large or small, where there is an industry or commercial house with a private side track and sufficient less-than-carload tonnage to load the prescribed minimum. The service is rendered for an industry which ships two or three cars per week as well as for one that ships hundreds.

The movement of inbound trap cars is much less than the outbound; the largest users of the service as a rule have comparatively little inbound traffic.

In general there is no charge on cars loaded to a minimum which at this time has risen on most roads to 12,000 pounds, as against 6000 pounds four years back. For less than the minimum the charges are now five dollars or more, as against two dollars at the earlier date.

The service should always be carefully checked to make sure that it is justified.

162. Car Records.—In the latter part of the year 1863, during the Civil War, the first action which resulted in establishing a Car Record Office was put forth on the Pennsylvania Railroad. The first car record was in the shape of large sheets ruled in a crude manner but arranged to keep the daily movements of home cars on home road.

The only records of car movement previously existing,

other than the agent's book record of loaded cars "manifested," were yard records prepared and kept at the several divisional and terminal points. These yard records were made up from card slips of the numbers of cars in trains moving East and West from yards by employees called Yard Clerks who were located at such points. These train cards, as they were called, each covered one train and were prepared in pencil from information taken from the sides of the car as the "made up" train passed, without regard to loaded or empty movement, and were copied in a book record at the yard office by trains, in columns by hundreds, so as readily to locate a car when required. In addition to this record of cars moved in trains from yards, a separate card list of cars standing on yard sidings was made and kept on file for reference when it was desired to locate cars or shipments by telegram or messenger from the main office.

Robert Pitcairn, afterwards widely known in railroad circles, was at that time in charge of train and car movement. A short time after this there was a change in officials which resulted in the removal of Pitcairn's office to Pittsburgh and in the appointment of John Reilly as Superintendent of Transportation. Reilly recognized the necessity for record of car movement closer to date than the records at the several yard offices and agencies provided and began at once to formulate plans for a centralized record of car movements at his office at Altoona. An inventory was resorted to in order to secure a basis for starting a record and for correcting and properly classifying the equipment. This inventory was obtained by yard employees located at divisional and terminal points, and revealed duplicate numbers, cars without numbers, a badly mixed classification, etc. These yard men were required to stencil on both sides of each car to the right of the car number, a character or mark such as a star, circle or square, as determined upon at each inventory, two or three inventories being necessary on account of the work being delayed or stopped by the conditions existing at the time. The purpose of the char-

acter or mark on the car was to avoid extra work and duplication of the car numbers, the yard men at a given point, finding the car already marked, would understand that it had been reported from another point. A report of the cars so marked showing the date, car number and kind of car was made to the Car Record Office daily by the "Yard Marker." These reports served not only as a check upon the cars in service, but as a guide to the proper numbering and classification of the equipment, as well as a basis for opening the new office record.

Improvements in the form of reports and records under a growing need were rapidly made, and a revised report from agents showing cars received and forwarded to destinations, which had been previously introduced at certain named points, became general. In addition, a report, at first received weekly, from yards and agencies of cars standing on sidings constituted the car record. Later large sheet reports, with columns to separate the car numbers by hundreds, made up by yard clerks from their book record of cars passing by trains were introduced, and at first kept on file for use in locating shipments, but later these were also incorporated in the book records.

At that time the freight trains as well as passenger trains were named, such as Through Freight, Fast Freight, Local Freight, etc., and from these sheets, which indicated the trains, the movement was recorded under the name of the train by use of an initial or abbreviation with the letter "E" or "W" to indicate the direction in which the train moved.

It should be observed that at that time reports of car movements were not made by conductors, so that the office record was simply a record of cars "moved from" or "passing," since the agents and yard clerks' reports did not indicate the points to which the cars moved or at which they were left by the train. It should also be noted that at the time to which the above refers standard gauge of track was not universal, freight was either transferred at junction points to the cars of connecting lines or by special

permission the car body was raised and the trucks of connecting lines substituted at such points where provisions had been made for handling the transfer of heavy shipments. The question of foreign cars, therefore, was of little moment; cars for the most part remained at home. Under these conditions no system of car service return for the use of foreign equipment was required or existed.

As the business of the country developed after the Civil War, the different roads gradually changed their gauge to the standard 4 feet 8½ inches. Then the number of foreign cars reaching the line of a railroad, and of the cars owned by that railroad moving to other lines increased rapidly.

These changed conditions brought up the question of car service return for the use of the equipment, which resulted in establishing, on a tonnage basis, a system of loaded car service returns, the empty movement not being considered.

This practice prevailed until the year 1876 when, under agreement with all roads, the mileage system, which included both empty and loaded movement, was adopted for arriving at car service earnings. This action necessitated establishing conductors' reports of cars moved in trains, which supplemented in the book records the movement of cars theretofore recorded from agents' and yard clerks' reports. It changed the office record from a record of cars forwarded or passing to a record of cars moving from and to given points, a decided improvement.

From the conductors' car reports the earning due foreign lines for car service was arrived at by entering on sheets prepared for the purpose, under the proper car initials, the amount of mileage made by a particular road's cars and this total at the close of each month was credited to the car owner.

As shipments over greater distances to foreign roads and more remote points increased, car demand grew and the question of the return of cars to the home road became a very serious one. Up to that time there were no junction reports from foreign roads, later introduced, showing the dispo-

sition of cars. By means of printed car tracers the movements to foreign roads beyond the immediate connections were arrived at, absent cars located and mileage return to some extent checked.

It has already been stated that the first method applied in settling for the use of the cars was the tonnage basis, which was changed in 1876 to the mileage basis. While the mileage basis was an improvement over the tonnage basis, this method proved to be somewhat crude and not altogether satisfactory, in that the car owner was without means to verify the correctness of the returns submitted by other roads, nor did it stimulate the return of the car.

Consideration by the American Railway Association of the question of a more satisfactory basis of compensation for the use of cars resulted in the adoption, as of July 1, 1902, of the per diem arrangement, under which each railroad pays the others the current per diem rate for the number of days cars of other than its own ownership are on its rails. The effect of this change upon the car record office was that whereas its efforts had been directed to securing the return to the home line of the cars owned by it, its efforts henceforth were to be directed to facilitating the return to the owning line of foreign cars.

A very good outline of the method of keeping car records is given by Johnson and Huebner in their "Railroad Traffic and Rates." From this book a system of keeping car records may be described as follows:

There are two general methods of keeping car records on American railways. The first is a card index system and the second, which is more widely used by the larger carriers, is a loose leaf ledger system. The work of the office is divided between two branches, the mileage department and the record department. The work of the former is limited to keeping mileage records of private freight cars and passenger cars, and its duty is to compute the mileage of all private freight cars and of passenger cars and the amount due on them, and at the end of each month to make a report to all the carriers interested so that they may make

the required settlements among themselves. Computations are made from the daily reports of train conductors showing all points from which and to which the cars were moved. The conductors are supplied with prescribed forms which enable them to indicate clearly the initial and number of each car, whether it is loaded or empty and the point from which and to which it is carried. Abbreviations and numbers are used in reporting the various sidings and stations. Junction points and terminals are largely designated by letters, and stations on the road are numbered consecutively with numbers indicating their respective distance from the initial station. In this way the work of the mileage department is greatly simplified.

The work of the record department is far more complicated and difficult than that of the mileage department. Its chief functions are to keep a record of the daily movement and exact location of each freight car so that lost cars may be readily traced, that any department interested may easily ascertain the whereabouts of any particular car, that errors in the interchange of foreign cars may be minimized, and that the transportation department may exercise a more effective control over equipment. Two sets of records are kept, one recording the movement and location of home cars and the other of foreign cars. In the case of home cars, the information furnished by the conductor's car report is transferred to a card in the index or a portion of a page in the ledger which is given over to a particular car in question. Because of the greater importance of the ledger system, it may be well to examine it somewhat further. Each leaf is so ruled as to facilitate the work of the office. In the usual car record book the numbers run down the left side of each page and the dates of the month run horizontally across the top, center, and bottom. Each day the numbers or abbreviations of the station from and whereto the car moved are entered under the proper date and constitute a means of tracing the car and ascertaining its location. The keeping of foreign car records involves an additional task of indicating the owner-

ship of each car and of computing the amount of per diem which the companies owe to each other.

Upon receipt of interchange reports at the car record office they are recorded and transcribed to junction reports and mailed at once to the car record office of the road owning the car, indicating which of its cars were that date interchanged and to what lines delivered. There apparently was no great change in the system described above until the "cut-up" system was adopted by a great many roads in 1913.

The "cut-up" system is a form made in duplicate, the narrow portion showing the initial and number, kind of car, where taken and left, and date, is ruled in such a way that each car may be cut up and sorted as to ownership for distribution to record clerks assigned to those particular cars. The wide portion or carbon copy is filed for reference.

On some roads the "cut-up" slips are made with a small hole in the end which allows the slips to be sorted on spindles on a board with the initial of each car of all principal roads over the top of each spindle. Smaller roads are grouped together by their first letter and according to books; for example, all small roads beginning with A are sorted on a spindle marked A, and so on through the alphabet. Other roads sort slips in a box made for that purpose. When this system is used it is not necessary to have record slips punched with a hole for sorting.

On a number of roads these slips are weighed on a delicate scale or measured by an instrument made for that purpose to show the amount of work done by each clerk. In this way it is known just how much work each clerk did on the previous day and at the end of the month a statement is made showing the amount of work entered during the month and the average for each clerk. This is used in connection with a statement furnished by the per diem department showing the number of errors on each book. These two reports are put together and the rank of each clerk is made from the amount of work entered and the number of errors on book. This statement is posted on the

bulletin board so that all may see the rank of each clerk. This has a tendency to improve records as each clerk will try to advance his rank.

There are a number of advantages in the "cut-up" system. One of the principal advantages is that each clerk receives work for only his particular book and is relieved of the necessity of going over a vast number of wheel and interchange reports to pick his particular cars. The reporting of junction records showing delivery of foreign cars to their connection is done by simply mailing out the original slip.

On a great many roads a check is made by all yard offices the last day of each month showing the initial and number of all cars on hand at that date. These checks are entered in the car record books for the assistance of per diem clerks that they may know if cars are still on hand. A weekly car balance statement is made showing the foreign cars on line and system cars on foreign lines according to classes of cars and divisions on which foreign cars are located.

Most yard offices keep what is known as a quick record book. This book is made up by the last two terminal numbers beginning with 00 and ending with 99. Conductors are required to furnish yardmasters with a train list showing in and outbound record of all cars they move. In entering records it is necessary for the index clerk to show the initial and the numbers preceding the two terminal numbers. Inbound records are entered in first space showing date of arrival with engine number or symbol designating that conductor. Outbound records are entered in the next space showing date of departure and train moving. The interchange records are also booked showing date received from connections and date delivered to connections.

163. Tracing Carload and Less Carload Freight.—The practice has grown up of tracing carload and less carload freight in order (*a*) to establish delivery at destination, (*b*) to locate lost and delayed shipments, and (*c*) to expedite movement and to furnish shippers and consignees with in-

formation as to location of shipments in transit so that probable time of arrival to destination may be determined.

There appears to have been no uniform method of tracing prior to 1903. During that year it was recognized that the increasing number of requests to trace shipments and the unsatisfactory results obtained through lack of method and uniformity in handling was a subject worthy of consideration and the Central and Western Association of Car Service Officers in February, 1904, appointed a Committee to investigate the subject.

After considerable correspondence it was learned that the handling of tracers was largely a matter of individual preference, and furthermore that the patrons of the railroads were not at all satisfied with the service rendered; that much of the tracing carried on was a useless expenditure of time and money and not productive of desired results. A strong sentiment was found to exist in favor of adopting a uniform method.

The Committee recommended that tracing be centralized, preferably in the office of the Car Service department to obtain the benefit of car records, instead of being distributed through several departments with the consequent duplication of work. There was some dissent from this plan, some roads claiming that the carload tracing should be handled through the car service department and the less carload tracing through the traffic or claim departments.

The committee also recommended the adoption of a message form with a numeral file and a prefix "X"; the originating road to furnish its connecting carrier with the necessary information concerning the shipment, together with date and point of delivery to that road; each road over which the shipment routed to furnish such information to its connecting line; the road making delivery at destination to notify the originator of the tracer direct, quoting, for the sake of brevity, the "X" file only instead of full reference to the shipment. The use of time freight, manifest freight and "red ball" freight was also approved by the committee.

The Association of Car Service Officers referred the subject to the Association of Transportation and Car Accounting Officers in the year 1906 which found that the indiscriminate and extensive commercial tracing being handled by the car service offices had assumed such alarming proportions that it reacted unfavorably upon the shipping public and defeated the purpose sought by overloading the wires and consuming time of clerks to no purpose.

The increasing demand of shippers for tracers was fast becoming a serious burden to the railroads, it being practically impossible to supply all the information asked for in connection with shipments in transit, some large concerns making a hundred or more shipments daily requesting tracers for each shipment at the time of forwarding or on the following day. The majority of the tracers were instituted by the shippers in the belief that the movement of the freight could be expedited but the great volume of such requests forced the railroads to disregard a great majority thus defeating the aim and purpose of many legitimate tracers.

The Association of Transportation and Car Accounting Officers on February 6, 1907, referred, with their recommendations, resolutions to the American Railway Association, which recognized the importance and necessity of placing some restrictions upon tracing, to reduce needless tracing in order that legitimate tracers might be given deserved attention. It was resolved that the tracing of a carload shipment at the time it was loaded constituted illegitimate tracing; that tracing should not be permitted until after a carload had ample time to reach destination.

Relief was earnestly hoped for, not only for the purpose of reducing the work in the car record office, but with a view to attaining increased efficiency and promptness in legitimate tracing, which was being demanded with increasing emphasis by the shipping public.

In April, 1907, rules were adopted providing that carload tracing should be handled through the car service department, and that no tracers should be started until the

shipment should have had sufficient time to reach its destination. Restrictions were also placed upon the use of telegraph wires, limiting their use to tracing shipments of perishable freight, highly important freight or freight which had been unreasonably delayed.

The rules brought about a temporary reduction in the number of tracing requests, but it was apparent that all railroads were not following the rules closely, and on May 17, 1911, the American Railway Association urged that the rules be strictly adhered to. It was also recommended that the tracing of small shipments should be confined to instances of unusual delay and that no tracing should be done until, in the usual handling of freight, the shipment should have reached destination. The relief sought was not attained.

Traffic managers of large concerns were increasing their requests, manifestly to obtain prompt dispatch, although it was charged in some cases that needless tracing was done to win repute with the management. Competition for traffic on the part of soliciting freight agents who are scattered throughout the country by the railroads also had its effect upon tracing as the agents were quite free in promising service together with information as to movement of the freight in order to secure business. A road which is in a position to furnish prompt and accurate information concerning shipments moving over its line affords a good argument to its soliciting agents in securing business. Railroads are now furnishing their outside agents with reports of all cars passing junction points. Tracing has been centralized in most cases in the car service department, the service of the car record office being of great importance. It is now the practice to trace shipments to junction points and advise the proper official of the connecting line, the date, time and place of delivery to such connection together with a proper description of the shipment, sending a copy of such information to the originator of the tracer, each road handling to do likewise, the road making delivery to notify the originator of the tracer direct. In tracing, if the reports of

car movements made by conductors and the reports of cars interchanged at junction points are received promptly and entered on the record books currently, the movement of the cars may be followed without sending out many wires for information unless the movements show undue delay or the car is crippled and shopped for repairs.

In tracing less than carload traffic, it is necessary to obtain the way billing reference, that is, the stations from and to, date and number of waybill, kind of lading, routing, etc., also the car loaded into and to what point carded to break bulk. It is necessary to trace through each transfer handling to learn whether or not the shipment was transferred to another car and if so the number and initial and to what point carded and so on until the shipment reaches destination. The practice of keeping a book record of all less carload shipments handled through the various transfers has become such a burden and expense that some of the larger roads have discontinued the practice, making it difficult, if not impossible, to follow the shipment to destination through transfers. The only recourse is to take up direct with the destination agent for delivery.

On February 9, 1916, the American Railway Association issued a circular stating that every year at least 5,000,000 telegrams and 3,000,000 letters were transmitted by railroads in tracing freight at an expense of over $1,000,000. At the present time it is felt that considerable unnecessary tracing is being done by shippers and receivers of freight, although there are instances where information as to location of freight is very important and failure to furnish it is sometimes followed by wholesale diversions of traffic.

The traders believe that tracing is effective in locating shipments and expediting movement. Though this may be true in a measure for carload traffic, it is a fact that few tracers for less carload freight ever catch up with the shipment, much less expedite its movement. The fact that some of the larger roads have discontinued records at the transfers makes it quite obvious that tracing to expedite or locate lost and delayed less carload freight is regarded as

a useless expenditure of time and money. The request to establish delivery at destination is often justified, however, since the consignee may refuse to pay the invoice of the shipment, claiming non-receipt in order to defer payment until a later date.

Tracing must be classed as a necessary evil with which the railroads must contend. It can, however, be remedied to some extent by improving the methods of handling freight, keeping records, etc., and by educating the shipping public to the necessity of confining their requests to cases of real importance. The railroads should handle each request on its own merits.

As a means of anticipating tracing, E. T. Keenan, Superintendent of Car Service of the Pennsylvania R. R. Company, introduced about 1917 the "checker board passing report." These passing reports, showing train number, time of departure, destination and a symbol letter for each train, with numbers and initials of the cars therein, are prepared at the yard offices as fast as the trains depart and at 6 P.M. the reports are closed and immediately placed upon the duplicator or hektograph film. Sufficient copies are run off for distribution to the various offices designated to receive them. In nearly all cases the reports are in the hands of Division Freight Agents and others using them the next morning. In many of the larger traffic offices these passing reports are spread out in a temporary binder each morning where they are consulted by representatives of the traders, who obtain by personal inspection information formerly sought for by tracers. These passing reports are particularly adaptable to the larger roads, their use is economical and the prompt information they furnish is of great value to the traffic officer and the public. Upon the smaller roads, the wheel and interchange reports as a general rule would reach the car service office as soon as the passing reports, so that the latter are not likely to find use on such lines.

164. Road Handling.—One of the most disappointing things in freight transportation is the comparatively short

time during which the car can be kept in motion on the road. The speed of freight trains can be increased only at the sacrifice of a part of the tonnage which the locomotive can haul, with the loss of some of the collateral economies, with increase in the expense of the upkeep of track, of fuel and supplies used, and an increase in the dangers of operation. Were it possible to increase the speed so much as 15 per cent, the gain in time in the division run would be only 22 minutes, involving sacrifices that the railroads could not possibly afford. As it is, the freight car is in actual train movement on an average of only two hours and 24 minutes out of each 24 hours. Much can, however, be done to increase the continuous movement of the cars, and to this end it is of the first importance that all obstructions be removed and every possible aid supplied. With the growth of traffic, better yard assembling, equated grades, and more power, we may hope for longer continuous runs with delays at intermediate terminals reduced to the minimum. Already we have such movement in the handling of much classified freight: the sixty-hour merchandise trains, New York to Chicago, the stock trains and those handling packing house products, the green vegetable and citrous fruit trains and others. The movement of coke and other commodities is at times organized on a similar basis. The time will probably come when the runs of engines will be much lengthened, when the crews will be shipped for a round trip of 1000 miles or more and the handling of the train more nearly approach the service on the high seas.

As we have seen we cannot expect materially to increase the road speed without disastrous economic effect, but we can greatly improve the facilities for continuous movement both over the operating division and through the intermediate yards. Together, these delays now consume more time than the road movement itself.

About one-third of the car mileage is made by empty cars. Every effort should be made to reduce this empty mileage, and, where cars run uniformly light in one direction, back loading should be actively canvassed for.

A fruitful source of trouble is the fact that, while the

traffic moves during the 24 hours of the day, on most roads the directing force, except the train dispatchers, work from 8 to 16 hours only. The office that distributes cars and power and controls the make-up of trains should never be closed. No car should be moved without certainty as to its destination. A daily inventory should be taken of the cars on the line at some stated hour; there should be a comprehensive system of carding at terminal points; the numbering of cars and the location of the numbers should be systematized and joint inspection service should be installed and kept at a high state of efficiency.

As every car in its average round trip is yarded four times and spends, on the road and in the yards, 7.41 days, or 49.7 per cent of the time, its history must be watched with care.

I made inventories, at different times, selecting week days when conditions were normal as to weather, traffic, etc., of the cars on line, and Figure 52 gives the results of one of these for Pennsylvania Lines West, August 31, 1901, and similar data for August 31, 1920, on the D. & H. and K. C. S. Companies' lines, and for March 9, 1921, on the D. & H.

FIG. 52.—TRAIN, ENGINE AND CAR SITUATION

	Penna. Lines West. 8 A.M. 8/31/01	K. C. S. 8 A.M. 8/31/20	D. & H. Co. 8 A.M. 8/31/20	D. & H. Co. 8 A.M. 3/9/21
Passenger trains on road	78	7	29	23
" cars on road	209	56	134	86
Freight trains on road	268	40	111	58
Work trains on road	47	2	14	12
Freight cars moving—loads	5,488	851	2,220	1,374
" " " —empties	2,320	388	968	1,076
" " not moving—loads	25,205	2,508	8,810	4,881
" " " " —empties	13,662	1,294	5,830	7,854
" " on line—loads	30,753	3,359	10,795	6,255
" " " " —empties	15,882	1,682	7,033	8,930
Average number of freight cars ordered per day for loading	......	654	1,743	1,308
Average number of freight cars furnished shippers per day	......	......	1,398	1,308

FIG. 52.—TRAIN, ENGINE AND CAR SITUATION—*Continued*

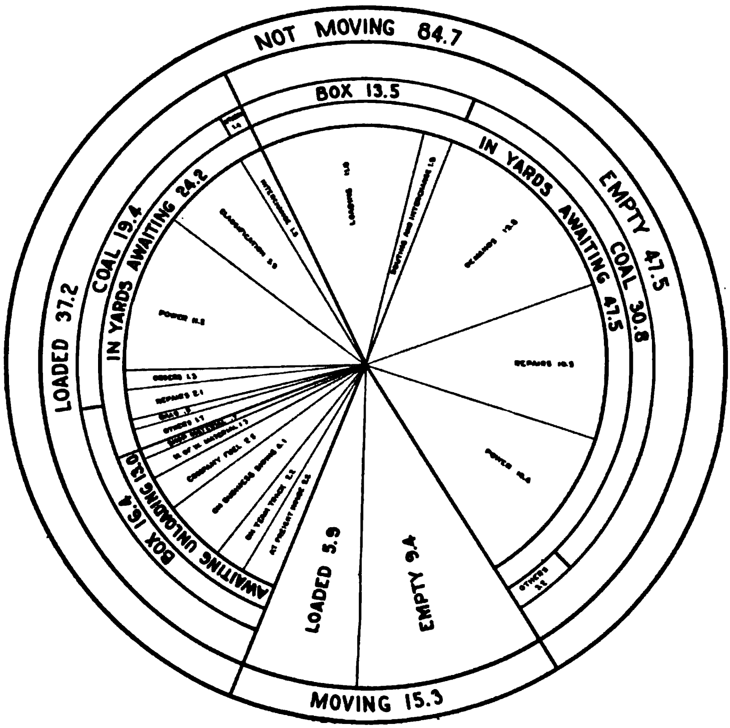
	Penna. Lines West. 8 A.M. 8/31/01	K. C. S. 8 A.M. 8/31/20	D. & H. Co. 8 A.M. 8/31/20	D. & H. Co. 8 A.M. 3/9/21
Average number of freight cars loaded per day	4,798	293	1,394	1,308
Per cent freight cars loaded	......	......	60	41
" " loaded freight cars not moving	82.8	74.6	79	78
" " empty freight cars not moving	86	76.9	86	88
" " all freight cars not moving	83.8	75.4	82	84
Freight cars not moving, box —loads	......	......	4,159	2,198
" " " " " —empties	......	......	1,636	2,316
" " " " stock—loads	......	......	21	42
" " " " " —empties	......	......	39	59
" " " " gondolas—loads	......	......	4,450	2,452
" " " " " —empties	......	......	4,002	4.956
" " " " flats —loads	......	......	107	106
" " " " " —empties	......	......	75	186
" " " " refrigerator —loads	......	......	53	67
" " " " " —empties	......	......	71	121
" " " " furniture—loads	......	......	20	1
" " " " " —empties	......	......	7	13
" " " " tank —loads	......	......	......	15
" " " " " —empties	......	......	......	203
Number of engines in stock—passenger	212	25		
" " " " " —freight	528	112		
" " " " " —switch	304	48		
Freight engines out of service				
Being repaired	75	19	36	43
Awaiting shop room	13	0	6	1
Stored	......	......	......	71
Condemned	6	0	0	1
Passenger engines out of service				
Being repaired	......	......	6	12
Awaiting shop room	......	......	1	0
Stored	......	......	......	7
Condemned	......	......	0	0
Yard engines out of service				
Being repaired	......	......	3	3
Awaiting shop room	......	......	6	1
Stored	......	......	......	9
Condemned	......	......	0	1
Total engines out of service—passenger	......	......	7	19
Per cent " " " " — "	......	......	8	22
Total " " " " —freight	......	......	42	116
Per cent " " " " — "	......	......	13	36
Total " " " " —yard	......	......	9	13
Per cent " " " " — "	......	......	9	11
Total " " " " —all classes	......	......	58	148
Per cent " " " " — " "	......	......	30	69

FIG. 52.—TRAIN, ENGINE AND CAR SITUATION—*Continued*

	Penna. Lines West. 8 A.M. 8/31/01	K. C. S. 8 A.M. 8/31/20	D. & H. Co. 8 A.M. 8/31/20	D. & H. Co. 8 A.M. 3/9/21
Engines in service				
Passenger—on the road	......	......	32	25
" —awaiting trains	......	......	27	25
" —"roundhouse attention"	......	......	16	15
Freight —on the road	......	......	177	133
" —awaiting trains	......	......	62	44
" —"roundhouse attention"	......	......	31	27
Yard —working	......	......	60	54
" —idle	......	......	14	
" —awaiting trains	......	......	......	12
" —"roundhouse attention"	......	......	14	7
Total engines in service—passenger	......	......	75	62
" " " " —freight	......	......	270	207
" " " " —yard	......	......	88	73
" " " " —all classes	......	......	433	339
Total engines in and out of service:				
Passenger	......	......	82	84
Freight	......	......	312	320
Yard	......	......	97	86
All classes	......	......	491	490
Freight cars not moving				
Empties awaiting loading	5,497	380	2,275	2,135
" " routing	212	4	36	106
" " demand	774	47	120	2,008
" " repairs	2,447	326	1,482	1,611
" " power	3,288	461	1,805	1,478
" " interchange	444	76	112	516
Loads awaiting unloading				
At freight houses	1,174	132	427	359
On team tracks	2,360	226	450	267
On business sidings	3,201	430	956	669
Company coal	806	48	288	426
Maintenance of Way material	1,029	75	193	151
" " Equipment material	245	3		
Shop material	......	......	198	69
Loads in yard awaiting:				
Freight house room	202	13	55	114
Team track room	259	35	93	2
Business siding room	2,963	75	413	135
Bills	251	91	97	17
Bill correction	23	3	13	7
Repairs	300	123	620	308
Orders	985	79	240	102
Power	6,191	760	2,065	1,385
Classification	1,496	259	1,484	727
Interchange	1,085	111	474	129
Loads stored:				
Account blocked yards	790	0	313	0
Awaiting consignee's orders	1,849	42	150	14
Awaiting power	54	3	281	0

It is astonishing to find how little the situation has changed in the long period of 20 years. It can hardly be that it presents no possibilities of improvement; rather it would seem a congeries of neglected opportunities. From the point of view of movement the main lines have always appeared to me to be a vast wilderness, the yards a rendezvous of sleeping Rip Van Winkles, while the facilities provided by the public authorities and the traders are as lean as Rozinante, Don Quixote's famous steed.

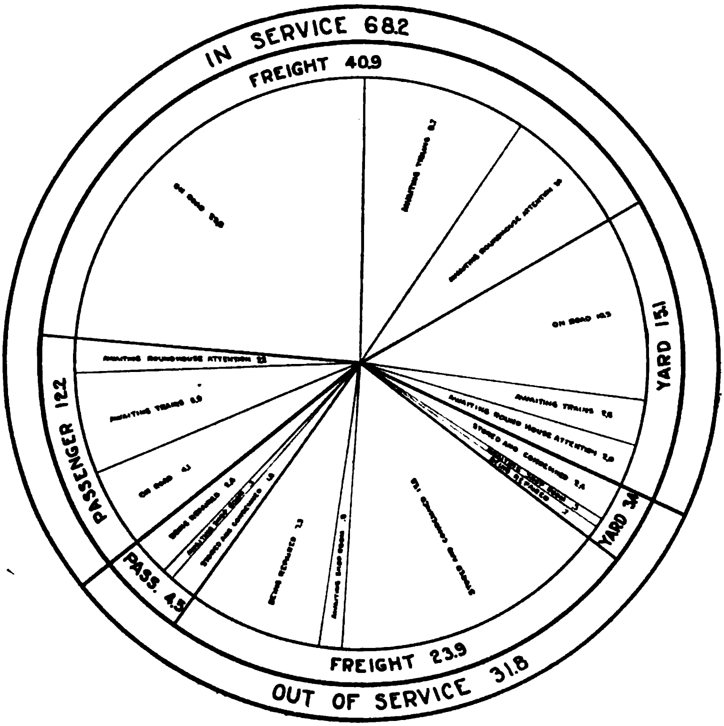
In the following graphs are presented composite averages of data similar to those in Figure 52 illustrating the



Classification of Freight Car Situation on the Lines of the Delaware & Hudson Company.

situations existing on the lines of the Delaware & Hudson Company on the following dates: August 31, 1920; March

5, 1921; June 8, 1921; August 31, 1921; March 5, 1922; June 8, 1922.



CLASSIFICATION OF LOCOMOTIVE SITUATION ON THF LINES OF THE DELAWARE & HUDSON COMPANY.

165. Bad Order Cars.—The United States Railroad Administration performance sheets show 7.1 per cent of the freight cars as unserviceable on December 31, 1919, as compared with 5.6 per cent on December 31, 1917, when they took over the roads, an increase of 27 per cent, or say 35,771 cars. But this by no means tells the full story.

The director general, in taking over the roads, began at once to create an organization. Now, it is impossible to extemporize an organization even if it could be shaped under a trip hammer with the heaviest blows, and this impossible adventure was the outstanding feature of his

failure, made the more certain by the inclusion of some men with little experience, of violent temper, and pronounced views.

Under the oversight of the "Railroad War Board" the Commission on Car Service had virtually pooled the box cars of the country by order issued April 26, 1917, and later the open-top equipment East of the Mississippi and North of the Ohio and Potomac Rivers was pooled by an order of the General Eastern Operating Committee issued on December 1, 1917. One of the things the Director General did at the start was totally to disregard the ownership of cars, to consider them all as a part of the equipment of the United States Railroad Administration, and to scatter them widespread over the country. The wasteful effects were evident in many ways, and one of the most significant was the rapid increase in "bad orders," not at all fully reflected in the figures of the reports, and the neglect of all the more important repairs by lines which regarded all equipment save their own as "foreign." In the early period of construction of all-steel cars, many of the parts were designed with too light cross-section, resulting in their more frequently calling for general repairs, and with their widespread distribution much delay was necessitated waiting for parts or because of the necessity of manufacturing parts for the repairs.

During the test period—1915, 1916 and 1917—years in which the war greatly influenced the situation, the owning line was able to keep on its own rails 586 cars out of each 1000 cars owned. During the guaranty period—March to August, both inclusive, 1920—the corresponding number of owned cars held on the owners' rails was 208 and, as during that time very great efforts were made to secure the return of cars to their owners, the condition at the time of the surrender of the roads by the Director General was certainly substantially worse.

From studies based on information covering the test period, received from 80 railroads owning 82 per cent of the freight train equipment of the country, the relation was

determined between the cost of repairs and the per cent of owned cars on home line. This gave, as the increased cost of repairs of cars on foreign lines, 31 cents on each normal dollar (see Figure 53). Worse even than this was the neglect of repairs, so that when the cars were finally returned extensive overhauling was found to be necessary.

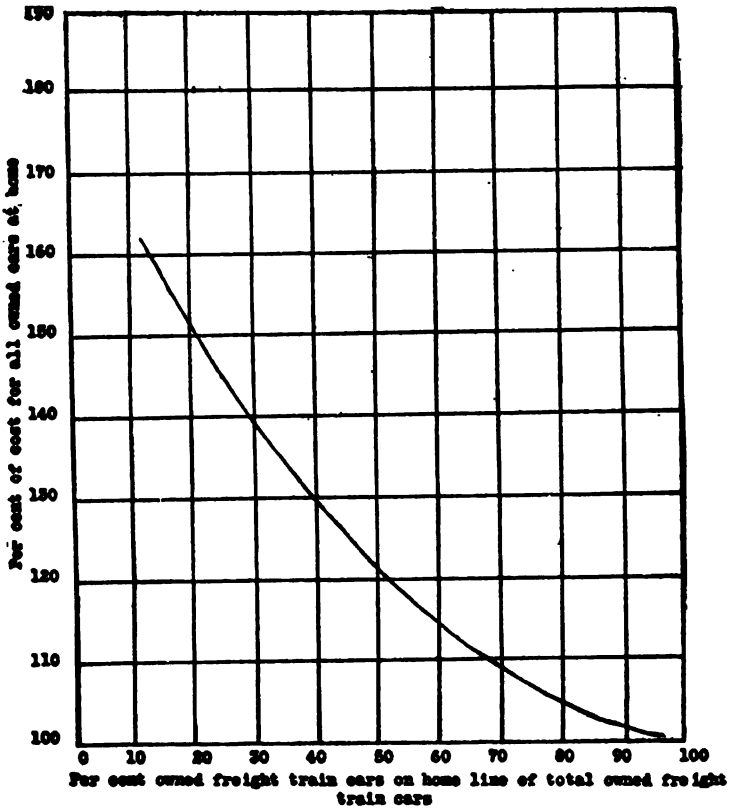


FIG. 53.—INCREASED COST OF REPAIRS OF FREIGHT CARS ON FOREIGN LINES.

METHOD OF DETERMINING EQUATION FACTOR FOR DIFFERENCE IN COST OF MAINTENANCE DUE TO DIFFERENCE IN PROPORTION OF OWNED CARS AT HOME

From studies based on information covering the test period, received from 80 railroads owning 82 per cent of the freight train

car equipment of the country, there has been determined the relation between the cost of repairs and the per cent of owned cars on home line. This relation is shown by the curve below, and shows that as the per cent of owned cars away from home increases, the cost of repairs per car per year increases. This conclusion accords with general experience, because it is recognized that the application of general repairs to equipment at the time needed produces a lower total cost of maintenance over a period of time than the application of temporary repairs plus the cost of deferred general repairs.

TABLE OF READINGS FROM CURVE

Column 1 = average per cent owned freight train cars on home line of total owned freight train cars.
Column 2 = per cent of cost for all owned cars at home.

Col. 1	Col. 2	Col. 1	Col. 2	Col. 1	Col. 2	Col. 1	Col. 2	Col. 1	Col. 2
* 1	179.32	21	150.55	41	128.94	61	113.61	81	104.39
* 2	177.73	22	149.30	42	128.02	62	113.04	82	104.05
* 3	176.15	23	148.06	43	127.09	63	112.48	83	103.70
* 4	174.56	24	146.90	44	126.17	64	111.91	84	103.36
* 5	172.97	25	145.56	45	125.24	65	111.34	85	103.02
* 6	171.46	26	144.46	46	124.43	66	110.81	86	102.76
* 7	169.95	27	143.36	47	123.61	67	110.28	87	102.49
* 8	168.43	28	142.27	48	122.80	68	109.76	88	102.23
* 9	166.92	29	141.17	49	121.98	69	109.22	89	101.96
*10	165.41	30	140.07	50	121.17	70	108.70	90	101.70
*11	164.01	31	139.01	51	120.41	71	108.26	91	101.51
*12	162.61	32	137.95	52	119.66	72	107.83	92	101.32
13	161.21	33	136.90	53	118.90	73	107.39	93	101.14
14	159.81	34	135.84	54	118.15	74	106.96	94	100.95
15	158.41	35	134.78	55	117.39	75	106.52	*95	100.76
16	157.09	36	133.80	56	116.75	76	106.16	*96	100.61
17	155.77	37	132.82	57	116.11	77	105.80	*97	100.46
18	154.44	38	131.83	58	115.46	78	105.45	*99	100.34
19	153.12	39	130.85	59	114.82	79	105.09	*99	100.15
20	151.80	40	129.87	60	114.18	80	104.73	*100	100.00

*Readings from curve projected beyond observations.

1. Average per cent owned freight train cars on home line of total owned freight train cars, test period..............	.58550
2. Average per cent owned freight train cars on home line of total owned freight train cars, guaranty period.........	.20811
3. Per cent of cost for all owned cars at home, test period. Find in column (1) number shown in (1) and use number opposite in column (2).............................	114.82
4. Per cent of cost for all owned cars at home, guaranty period. Find in column (1) number shown in (2) and use number opposite in column (3).............................	150.55
5. Equation factor for difference in cost of maintenance due to difference in proportion of owned cars at home, (4) divided by (3)....................................	1.31118

The proper care of cars demands constant vigilance. Distinction should be sharply drawn between repairs requiring the withdrawal of cars from service and repairs that may be made without cutting the car out of the train, and the work should be organized accordingly. In many cases transfers of lading are necessary, while in others it may be advantageous to repair the car under load.

Formerly there were many cases of delays on interchange tracks from disputes between car inspectors, but the organization of joint inspection and the perfecting of Master Car Builders' rules have greatly improved this condition. It remains, however, one of the points to be carefully watched.

During the month of January, 1921, there was a movement of 59,614 cars through the Oneonta yard of the Delaware and Hudson Co., an average of 1923 cars daily. Each of these cars was twice examined by inspectors to determine whether it was in safe condition for further road movement or required repairs, the first inspection being made by car inspectors immediately upon arrival of car in yard, and the second inspection just previous to departure from yard by air brake inspectors of condition of hand brakes to insure observance of the Interstate Commerce Commission's regulations and also to "cripple" any cars which they found to be otherwise defective. Every car requiring the application of any material or labor is counted as a cripple, and of the total cars inspected during the month 10,038, or 17 per cent, were crippled.

According to the amount of labor required to make the necessary repairs, bad order cars are classified as follows:

Light repairs, No. 1, requiring from 0 to 10 hours to repair
Light repairs, No. 2, requiring from 10 to 20 hours to repair
Heavy repairs, No. 3, requiring from 20 to 60 hours to repair
Heavy repairs, No. 4, requiring over 60 hours to repair

Repairs formally known as "Running Repairs," are now included in "Light Repairs, No. 1," and are usually made without setting cars out of trains. Generally light repairs

are made under load but heavy repairs are not. Cars requiring heavy repairs must be switched to a shop or repair track. For some time past it has been the practice to set aside a track on each side of the operating yard to be used exclusively for making light repairs requiring a minimum amount of attention, thus obviating the delay incident to switching cars to and from shops.

Figure 54, which follows, gives the percentage of cars crippled during the month of January, 1921, in which it will be observed that 83.2 per cent of the total cars crippled were repaired at the point where crippled and without causing any additional delay to the car. The delay involved in connection with the balance, which were sent to shop or repair tracks, is shown in Figure 55.

FIG. 54.—CARS CRIPPLED DURING JANUARY 1, 1921

Movement through Oneonta Yard		Total Cars Crippled	Classification of cars crippled					
			Repaired in train.		Sent to repair tracks or shops			
			Running repairs		Light repairs		Heavy repairs	
			D & H.	Foreign	D & H.	Foreign	D.&H.	Foreign
Month of January, 1921	59,614	10,041	3936	4419	614	979	81	12
Daily average	1,923	323.90	126.97	142.55	19.80	31.58	2.61	0.39
Percentage........		16.8%	39.2%	44.0%	6.1%	9.8%	0.9%	0.1%
Total percentage...		......	83.2%		15.9%		0.9%	

From Figure 55 it appears that 11.1 per cent of the detention to cars held for light repairs is due to yard delay; 2.6 per cent is shop delay consumed in time car is actually undergoing repairs; 35.3 per cent is chargeable to shop delay covering period intervening between work days and time held up for material; and 51.0 per cent is on account of switching delay both to and from the shops.

From the time the car arrives in the yard, or from the time it is crippled until it is switched to track No. 2 southbound classification yard, or No. 8 northbound classification yard, upon which track cripples are assembled, it is charged to the Transportation Department and shown as Yard Delay in the above table. Shop locomotives under the jurisdiction of the Divisional Car Foreman handle cars from these two tracks to the desired shop or repair track, and time so consumed is shown under Shop Switching Delay (delivering). After a car is delivered to shop or repair

Fig. 55.—Delay in Repairing Crippled Cars

	Yard Delay						Shop Delay														
	(Switching to Class-Track)			Switching (Delivering)			Actually undergoing repairs			Intervening Time			Switching (returning)			Total			Grand Total		
	Dys.	Hrs.	Min.	Dys.	Hrs.	Min.	Dys.	Hrs.	Min.	Dys.	Hrs.	Min.	Dys.	Hrs.	Min.	Dys.	Hrs.	Min.	Dys.	Hrs.	Min.
Light repairs																					
D. & H. cars	..	6	21	..	18	29	..	1	39	..	20	46	..	8	40	2	1	34	2	7	56
Foreign cars	..	6	32	..	22	39	..	1	24	..	20	9	..	9	24	2	5	36	2	12	8
Heavy repairs																					
D. & H. cars	..	6	54	..	20	11	..	23	11	62	14	17	4	3	19	68	12	58	68	19	52
Foreign cars	..	7	44	1	..	30	..	26	37	10	10	44	1	18	25	14	8	16	14	16	

track, detention is separated to show time car is actually undergoing repairs, and the intervening time when car is not being worked on due to the period between work days, holidays, time held for material and time car is outstanding. A car is considered under the jurisdiction of the Car Department until returned to the Receiving Yard Track by the shop switch crew. The detention from the time repairs are completed until the car is actually returned to an operating yard track is shown above as Shop Switching Delay (returning). It will be noticed that this item for heavy repairs runs into several days' detention, apparently due to insufficient switching service, the crews engaged

in this work also doing switching for the Mechanical and Stores Departments. When returned to receiving yard track after repairs are made, the car makes the normal yard switching movements, the same as a car arriving in the receiving yard and passing inspection.

It is evident that the conduct of the work of inspecting the cars, their prompt marshaling and movement to and from the repair tracks or car repair shops, and the speed with which the work is done, offer large opportunity for careful yard design, organizing ability and for painstaking administration. The very large number of cars requiring running repairs would appear to indicate a field in which improvements in design and character of material used might be expected to produce large economies, as well as much relief in obstructions to movement.

The mileage of new cars requiring few repairs, and that of old cars the condition of which has not been fully maintained, will show an increase of as much as 16 per cent because of less bad-order detention.

166. Sailing Day Plan.—The "sailing day" plan of handling less carload freight was developed by the Pennsylvania Railroad about the middle of the year 1917, after a very careful study as regards conservation of man power and cars under stress of war conditions.

The original plan provided for the inauguration of sailing days semi-weekly, tri-weekly or to be otherwise determined by the volume of business offered; the purpose being to concentrate less carload freight at the point of origin automatically into carloads, each for a single destination.

Freight was to be accepted for shipment on the specified sailing days only, doing away with the necessity of holding freight in freight houses one, two or more days with the attendant liability of damage in rehandling, loss by theft, etc. The cars were to "sail" as arranged, insuring a dependable service.

Large cities having several freight stations were to have particular stations designated at which freight would be exclusively received for specified destinations.

One of the most important features was to notify and instruct all shippers of less carload freight of the plan and secure their coöperation in delivering shipments to the freight houses on sailing days only.

The benefits to be derived may be stated as follows:

1. Loading cars full and carding to destinations, eliminating delay and expense in rehandling, and consolidating small shipments into full carloads at transfers resulting in quicker service.
2. Conserving man power by avoiding transfers enroute.
3. Conserving car supply by heavier loading than was believed possible under the transfer system and insuring a more prompt movement.
4. Reduction in train movements, local way freights to be operated tri-weekly, instead of daily except Sunday, whenever possible.
5. Promoting regularity of less carload freight service by simplifying operation, eliminating large proportion of rehandling at transfers, thereby reducing liability to damage.

The plan was put into operation by the Pennsylvania Railroad at Philadelphia, September 4, 1917. The tryout marked the plan as desirable and on March 16, 1918, it was extended to cover all the 25 divisions east of Pittsburgh and Erie, the reports from all divisions showing a daily saving of 654 cars and discontinuance of 20 local way freights daily.

The ruling of the Railroad Administration on December 29, 1917, providing that the designation of routes by shippers was to be disregarded when speed and efficiency of transportation might be promoted, worked out to good advantage in the Sailing Day Plan as all freight for a given point could be forwarded via any direct route, doing away with the necessity of making separate cars via the several routes to any given destination.

The scheme spread to many other roads and five and one-half months' experience proved that it not only economized in use of car space but gave shippers a more regular service and reduced the length of time in transit; furthermore, reducing rehandling at transfer stations, loss and damage claims and amount of freight going

astray. It was also effective in reducing congestion of teams and trucks at shipping stations and economized labor of both carriers and shippers.

The plan apparently continued to meet with increasing success, as shown by letters from shippers and consignees in the northwest region. On March 20, 1919, the Car Service Section issued bulletin No. 6 advocating the Sailing Day Plan and submitting figures from several railroads showing the benefits derived. With the passing of actual war conditions, however, there was a noticeable amount of criticism directed against the plan by various shippers. The *Railway Age* of May 2, 1919, published an article under the caption "Development and Death of the Sailing Day Plan," stating that the plan had been viciously assailed for many weeks by shippers and their organizations, that the National Industrial Traffic League at its meeting at New Orleans, La., on March 11, 1919, passed resolutions voicing vigorous complaints of the shippers, declaring its necessity as a war measure had passed, that it was a restriction upon commerce and that the railroads had failed in their legal obligations to receive and dispatch freight with reasonable promptness, inflicting hardship on receivers of freight as well as extra expense on the shipping public.

The principal objections were based on refusal of carriers to receive freight on other than sailing days and undue discrimination between markets; shippers at large points where full carloads were accumulated promptly being able to make shipments daily whereas competing shippers at smaller stations had to be content with semi- or tri-weekly sailings.

A committee was formed of National Industrial Traffic League members which presented the shippers' objections to the railroad administration and requested the amendment or abolition of the plan. The railroad administration at once acquiesced in the principles laid down by the committee, a political rather than a transportation decision, as the plan had previously received the support of the railroad administration.

The foregoing action was denounced by the car service officials in the *Railway Age* of May 9, 1919, who stated that the plan originally adopted as a war measure had received official sanction and that the National Industrial Traffic League representing the shippers had pledged its support and coöperation to make the plan a success and a permanent measure. The meeting resulted in some changes which removed many of the objections made by the shippers and preserved the principle and advantages of the plan.

Under the modified plan shippers were to be permitted to route freight over any line at legal rates applicable and were given permission to deliver freight to carriers on any business day, the carriers retaining the sailing day privilege.

Freight not specifically routed by shippers was to be forwarded via preferred routes based on consideration of convenience to shippers and consignees, economy and expedition of movement, proper recognition of non-federal controlled lines; daily service to be given to the greatest possible extent and the schedules of sailings to be furnished shippers.

Peddler car service was to be operated daily except where more limited service was agreed upon by shippers and carriers or authorized by lawful regulations. The operation of such peddler car service was not to be construed as requiring establishment of additional train service.

It is recognized that the plan operated favorably during the war. The non-observance of routing instructions, absence of freight solicitation, together with the patriotic support of the public contributed in no small measure to its success. The principle of the plan is well founded and the original idea with a few modifications, now known as the shipping day plan, is still in effect and retains advantages favorable to both the shipping public and the railroads. The return of the roads to private management, with the consequent recognition of routing instructions and keen competition for traffic, has affected the plan somewhat adversely.

While the shipping day plan is an improvement over the old method, there are greater possibilities to be attained

by further thought and study which may evolve a new plan, reconstructed from the old and designated as through expedited package car service or some similar designation which will identify its purpose and appeal to the shippers.

The handling of less than car load freight is a matter of much importance. The large amount of equipment in-

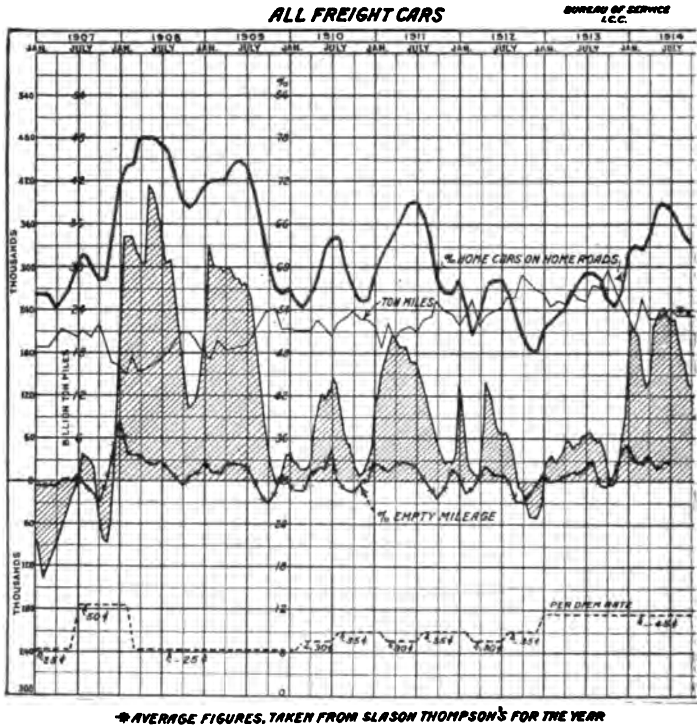
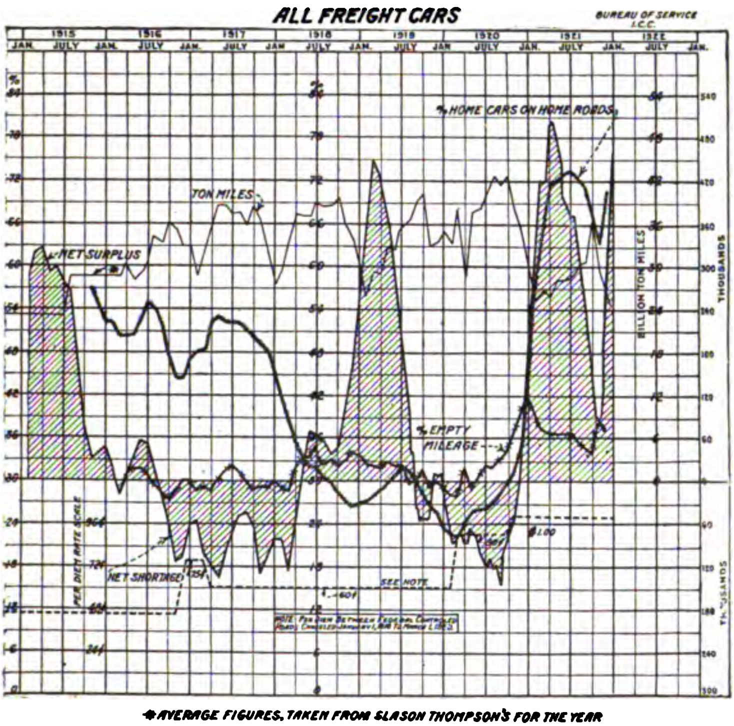


FIG. 56.—CAR SHORTAGES AND SURPLUSES; PERCENTAGE OF HOME CARS MILEAGE

volved, 20.6 per cent of the total, and the very light loading, less than eight tons per car, and only about four per cent of the total tonnage moved, justify the giving of far more attention to this matter than has obtained in the past.

167. Loaded and Empty Mileage.—It is only in the handling of loaded cars that earnings are made, while the expense of handling the empties may, all things considered,

run practically as high as that of handling the loads. Some data that I assembled in 1903–1904, showed annual earnings for open top cars of about $800 per year, and for closed cars about $1200 per year. With the increase in the carrying capacity and in the rates, the earnings of the average car are somewhat less than $1500 per year.



ON HOME LINES; PER DIEM RATES; TON MILES AND EMPTY CAR (1907–1921).

One of the great dangers of excessive car supply is its wastefulness, and this may be nearly as costly as if the supply were insufficient, efficiently and economically to move the traffic offered.

Munhall figures that in the Merchant Marine about 20 per cent of the sailings are made in ballast; that is, the boat has no revenue freight. In 1894 the empty car mileage

was 33 per cent. The normal empty mileage is now about 32 per cent of the total, but at times for short periods runs up as high as 43 per cent. The return of cars to the owning roads when commercial depression sets in increases the empty movement.

Reference to Figure 56 will show that beginning in the latter part of 1920 we had:

1. The most severe car shortage yet experienced.
2. The smallest percentage of home cars on home lines.
3. The highest per diem rate yet paid, which was accompanied or followed by the sharpest decrease in volume of business (ton miles) ever known, which developed the greatest surplus yet experienced.

This brought about the quick return of home cars to home lines, and was accompanied by the highest percentage of empty mileage yet recorded, a cause of much comment. With the decline in tonnage movement, which set in in the fall of 1920, equipment began to be relocated according to ownership. The southern roads experienced a sharp reduction in the northward movement of lumber, etc., the western roads a similar decline in the eastward movement of grain, etc., while the movement of the products of manufacturers and mines in the eastern region fell away heavily. The traffic, usually moved in box cars, which normally make an empty mileage of less than 20 per cent, decreased two and one-half times as much as the open top car traffic which has a normal empty mileage of about 40 per cent. The increase of home cars on home lines, the lack of orders for cars for loading and the high percentage of cars needing repairs caused a very large increase in the number of cars billed home for repairs.

This movement was accelerated by the action taken by the Advisory Committee of the Association of Railway Executives. Believing that it was of primary importance that freight cars be relocated on the home roads as rapidly as possible, they had put in effect a temporary arrangement designed to promote this end, effective September 1, 1920.

Recognizing that this involved an excess movement of empty cars, rules were adopted to reimburse the railroads incurring the same at the rate of five cents per car mile for the movement but not relieving them of per diem charges; the amount of such claims to be assumed by all the roads members of the American Railway Association on the basis of the loaded freight car mileage made within the period, that is, the six months, March 1 to August 31, due consideration being given to the principle of equalization of car movement between carriers, and of restoring to the owning road the substantial equivalent of its ownership. The movement was by no means completed on August 31, and was not over until about March 1, 1921, when the relocation was accomplished and normal conditions restored.

The movement was much accelerated by a change in the car service rules whereby each road is entitled to deliver to the other as many cars as it receives, provided only they are moving in the direction of home. Such an arrangement works much faster in getting cars home than the one previously in effect, and is accompanied by a more violent fluctuation in the empty mileage figures. The movement will not extend over so long a period, nor will the empty mileage in total be so great as under the previous method.

168. Car Pools.—A suggestion much favored by some for increasing the use of the equipment and avoiding empty mileage is the pooling of cars for traffic regions or for the entire country.

In 1907, at a time when business was very heavy, the American Railway Association approved a plan for the pooling of certain box cars, but it was never put into effect. In November, 1917, under the pressure due to the disorder created by the abuse of "priority orders" by government officers, the Eastern Lines pooled their cars. Under the director general all cars were considered as the equipment of the railroad administration and were in effect pooled. Although nominally abolished with the return of the roads to their owners, the pool was virtually continued for some time afterwards.

Both of these pools were failures. During federal control financial interests were not affected, but both before and after many car owners suffered through failure to recognize financial requirements. There was no effective plan of distribution. The transient ideas of the central distributing office concerning the daily situation formed the controlling influence. Toward the end of federal control, coal cars were nominally distributed between roads on the basis of a uniform system of mine ratings, but the ratings were nominal and the supervision so imperfect that the results were frequently unfair. The outstanding failure, however, and one not fully uncovered during the short period of experiment, was the failure in car maintenance.

Both the Pennsylvania and Burlington Systems, whose main and subsidiary companies were large owners of cars, a long time ago placed them in common pools with full recognition of the property rights in them and have successfully operated their pools for many years. Their success was due to their full recognition of the following principles:

1. Each owner whose cars are placed in the pool must receive full compensatory allowance for their use.
2. The cars must be fairly distributed.
3. The repairs must be made at the points best adapted to the work and the expense of the repairs fairly charged.

During time of car surplus, a chief difficulty is in the inordinate amount of empty mileage. There is great temptation, frequently yielded to, to avoid a fair distribution of the cars. They are, however, kept in good repair.

During times of car shortage, the financial interest of the car owner is ignored, the distribution is unfair and repairs are neglected or made at the wrong places.

No progress in car pooling will be made until these three principles are fully recognized. No single pool can succeed for the continent nor for any traffic region. Pools to succeed should be limited to cars of one kind. No pool should include cars adapted only to the use of the owner.

My own feeling is that experience has shown that the

movement of cars can be properly controlled by the car service rules if conscientiously observed, with such modifications as may be temporarily arranged between connecting lines.

As has been said elsewhere, the growth of the traffic has involved the common use of the cars over wide areas, and justice to the owner, as well as economy and efficiency in their use, must be worked out either through the pools or the car service rules or both.

On the other hand, joint ownership in what might be called "massed" equipment, as contrasted with "pooled" equipment, for the movement of special traffic is an economic device that may well be encouraged. Such an organization has been effected by some of the roads serving the southeast, which took over from Armour and Company the refrigerator equipment which it supplied for service in that territory, operating the same in joint interest. This method of handling special traffic will probably be followed in other regions.

169. Per Diem.—As early as 1867, a Royal Commission in England, examining into railroad practices, recommended that in the dealings between roads a charge be made by one against another for the use of its cars, by way of rental, on a basis of time held instead of distance moved. From the first, in this country, the charge had been made on a distance basis, and in 1870 the mileage rate of payment was one and one-half cents per mile run loaded, no charge being made for the empty movement. Among other difficulties that of accounting led to the modification of this practice, and a charge was made of three-quarters of a cent per mile run whether loaded or empty, and later this was fixed at six mills.

The car equipment was the subject of very great abuses. It was the common practice for roads to hold foreign cars idle for weeks, acting as agents for the solicitation of freight or using the cars as warehouses for the accommodation of traders. In the handling of seasonal traffic, such as grain, the originating road would for weeks, and sometimes for months,

set off and hold empty foreign cars in anticipation of loading. All lines owning adequate equipment maintained skilled corps of "car tracers," who traveled about the country locating their cars on foreign lines and pleading and cajoling for their return. As in the days of "wild-cat" bank notes, when the issue was taken to distant points to be put in circulation, so in times of light business some roads that could not keep their cars profitably employed on their own lines, sent them to distant points with insignificant loads in order that they might earn mileage. At the Car Accountants' Convention of 1894, this knavery was fully canvassed, one road reporting, as a sample, a car from Vermont billed to a point in the far west, sealed and in bond, to cross through Canada, containing one tub of butter. As a defense against this abuse, the practice arose of carefully examining all foreign cars and consolidating their loads at a transfer station, returning the empties with their journey cut short. Besides the saving in the payment of car mileage this also reduced the train mileage. The difficulties of accounting were very great, the owning company being absolutely dependent upon the returns of the using company on which there was no satisfactory check. About $44,000,000 were changing hands annually in settlement of mileage accounts. Each year, at the Car Accountants' Convention, disclosures were made of "short mileage" returns. So disgraceful a condition could not continue. The suggestion began to be discussed of charging by time instead of by distance, thus making it possible for the owning road to demand an accounting for each of its cars for the 365 days of the year, transferring from the owner to the non-owning user the incentive for the prompt movement of the car and entirely changing the methods of the car record offices and their attitude toward the subject.

In 1876 J. T. Rigney, the Car Record Officer of the B. & O., brought forward a per diem plan, but its details were considered impracticable and it did not receive serious attention. In 1900, through the influence of J. W. Midgeley backed by a number of large railroads, the "Bureau of Car

Performance and Statistics" was organized to "investigate the question of mileage and per diem," but this fell away without definite action. Two years later, Arthur Hale, then Assistant General Manager of the B. & O., advised me that he thought if a determined effort were made the per diem plan could be brought about, and he was detailed to give the matter his entire attention. The plan was adopted by the American Railway Association on April 24, 1902, the rate being fixed at 20 cents per day with a penalty of 80 cents per day additional where the possession of the car was retained more than 30 days.

The per diem rates, fixed in the early stages, were based upon rough assumptions, and reflected the efforts to quiet the apprehensions of some and restrain in others the abuse of the strength of their position. On February 7, 1908, the American Railway Association appointed a commission of five:

James McCrea, Chairman. Vice Pres., Pennsylvania Lines West
W. W. Finley.......... President, Southern Railway Co.
Howard Elliott......... President, Northern Pacific Ry. Co.
Lucius Tuttle........... President, Boston & Maine R.R.
Julius Kruttschnitt, Director, M. & O., Union Pacific System.

to determine, first, the amount per day which the using road should pay the owning road for the use of its cars, and second, to devise an effectual method to secure the enforcement of the existing rules for the return of the equipment on demand.

The committee reported that it was evident that cars must yield to their owners a fair return upon the investment in them, or it would be impossible to find capital for their construction. They compiled an intelligent and careful analysis of the freight car equipment of the country, its cost and expense of maintenance, enlisting in the work many of the most competent experts in the country. They decided that the elements that would properly enter into the determination of the expense of owning freight cars were: the cost of repairs, replacements and taxes, the interest on the cost of the car, and the other determinable allow-

ances incident to ownership. Insurance was not considered as an element in fixing per diem because the using road insures the car for the owner while in its possession. The insurance expense was estimated at $1.17 per car per year, or three and two-tenths mills per day.

The Transportation Section of the American Railway Association reviewed the matter in August, 1920, and found no reason to change the methods followed. It will economize space to discuss the two reports together. The equipment was found to consist of:

CARS

Capacity in pounds	1902	1907	1920
100.000 or over	5.3%	16.9%	41.0%
80.000 and less than 100,000	13.7	25.3	32.5
60,000 " " " 80,000	43.4	41.1	24.6
50,000 " " " 60,000	16.1	9.1	1.4
40,000 or less	21.5	7.6	0.5
Total	100.0%	100.0%	100.0%
Total number of cars	1,546,101	1,991,557	2,241,755

(*a*) *Repairs.*—1909.—The amounts paid foreign lines for repairs to system cars averaged $15.23 per car, and the amounts received from foreign railroads and the owners of private cars for repairs made by the using road averaged $18.35 per car, the latter including private cars such as refrigerator and other special types, the cost of repairs of which was greater per car than that of those owned by the railroads.

1920.—The cost of maintenance, as reported for the year 1919, was 51.87 cents per car per day. The committee considered that, having regard to the known rise in the cost of labor and materials, this figure should be increased 20 per cent, and the cost of repairs fixed at 62.25 cents per car per day.

(*b*) *Replacement.*—1909.—The replacement charge was calculated by taking the difference between the "total net cost of repairs, excluding replacements," and the "total net cost of repairs, including replacements," as shown by the

accounting methods then in vogue and averaging them per car. It was fixed as an average for the six years 1902-1907 at 5.71 cents per day, and for the year 1907 at 7.39 cents per day.

1920.—The committee took the rate of depreciation reported by the railroads for the past 15 years in accounting under the Interstate Commerce Commission rules as 3.41 per cent of the cost of the car and, regarding that as abnormally low, in view of the great rise in prices during the period of the war, fixed the charge at 9.97 cents per day.

(*c*) *Taxes.*—1909.—The committee found that in six years the taxes had increased from $1.93 to $2.62 per car, or 0.72 cent per day, or an apparent increase of 35.2 per cent in the rate; but the value of the car had also increased, so that the increase in the rate of taxation was 16 per cent.

1920.—The average taxes as reported for the year 1919 were $7.82 per car or .757 of one per cent of the average value of the cars reported. Using the same basis for the average of old and new cars for the year 1920 gave $8.38 per car per year or 2.29 cents per day.

(*d*) *Interest on Cost.*—1909.—The estimated cost, that is the purchase price, as reflected in the average cost of the cars in stock had increased from $620 in 1902, to $722 in 1907, due largely to the increasing percentage of large capacity cars, which were as might be supposed more costly than low capacity cars. These estimates were thought to be accurate within 5 per cent, and such errors as there were tended to make the average costs for the earlier years appear larger than they probably were. The rate of interest assumed in calculating the charge was five per cent, though the prevailing rate at the time was four per cent. The charge was fixed at 9.89 cents per day.

1920.—The committee estimated the average cost of the cars in stock in 1918 at $955.61, and in 1919 at $1,032.88. The new equipment purchased since January 1, 1918, had cost $3,045.65 per car and the estimated average cost for the year 1920 was fixed at $1,107.20. The committee regarded six per cent as an equitable rate of interest, having regard to the lower rate fixed by the car trusts under which

many of the cars were bought, and the abnormally high rates on the moneys for equipment recently acquired. This amounts to $66.43 per car per year, or 18.20 cents per day.

(*e*) *Other Allowances Incident to Ownership.*—1909.—The price to be paid to the owning road by the using road should include a sufficient amount to compensate the owning road fully for the risks of ownership and for the loss of the use of the car at times when the owner needs it and this was fixed at two and one-half per cent and amounted to 4.95 cents per day.

1920.—The committee contented itself with the statement that the allowance should be increased, and fixed it at 6.5 cents per day. This comment must have referred to some intermediate rate since, had it been based on the contrasting cost of the cars at the two periods, the allowance would be 7.13 cents, while if the increase in the interest rate was considered the allowance would have been 8.55 cents.[1]

[1] The report of the general committee of the A. R. A. contains the following comment on the basis of this:

OTHER ALLOWANCES INCIDENT TO OWNERSHIP

This does not represent in any sense profit, but is a compensation to which an owning road is rightfully entitled for the large percentage of time which cars must remain idle during periods of car surplusages with interest, depreciation and taxes going on and car not earning any revenue to the owner. This item was considered proper by the McCrea Commission in 1909 as an element of ownership cost and was considered at the time the 60 cent per diem rate was fixed. The allowance used at that time was 5 cents which we have increased 25 per cent on account of the increased maintenance cost of the car.

SUMMARY

Per diem charge	McCrea, 1909 Committee	A. R. A., 1920
Cost of repairs	17.58¢	62.25¢
" " replacements	7.39	9.97
" " taxes	.72	2.29
" " interest	9.89	18.20
" " other allowances	4.95	6.50
Total	40.53¢	99.21¢
Average cost of car	$722.00	$1,107.20
Interest rate	Five Per Cent	Six Per Cent
Number of cars	1,800,000	2,779,489
Per diem charge recommended	40 cents	$1.00

The committee of the Association of Railway Executives having reviewed the report and recommended a per diem charge of $1.10 per car, the matter was submitted by letter ballot and the proposal was lost. The various rates that have been in effect with the date of their institution are:

RATES—WHEN INSTITUTED

Date	Rates in cents
July 1, 1902, to June 30, 1906	20
July 1, 1906, to June 30, 1907	25
July 1, 1907, to February 28, 1908	50
March 1, 1908, to February 28, 1910	25
March 1, 1910, to December 31, 1913:	
March to June, inclusive	30
Other months	35
January 1, 1913, to December 14, 1916	45
December 15, 1916, to March 31, 1917	75
April 1, 1917, to February 29, 1920	60
(Per diem rate between roads under Federal control suspended from December 31, 1918, to March 1, 1920.)	
March 1, 1920, to October 31, 1920	90
November 1, 1920, to date	100

It is significant that since the introduction of per diem in 1902, there has been no instance of a suggested return to the mileage system of settlement.

But there remain unsettled questions of the first importance, some of which have been recognized from early times, some of them discussed without decision.

In the consideration of the per diem charge to be made, the committee carefully considered:

1. The difference made in the use of the cars.

   (*a*) The considerable spread between the lighter and heavier capacity cars.
   (*b*) The fixing of rates for the different traffic regions.
   (*c*) A preferential charge for special equipment.

The Committee of 1909 decided on a universal per diem regardless of capacity, age and other conditions affecting the car.

The General Committee of the Transportation Division, American Railway Association, has been considering the early establishment of graded per diem, taking into consideration the various capacities of the cars. This contemplates a per diem charge of 60 cents per day per car for cars under 80,000 pounds capacity, 80 cents per day for cars over 80,000 and under 110,000 pounds, and one dollar per day for cars of 110,000 and over. To give effect to such a plan it would be necessary to add to the interchange sheet a column showing capacity. Any method which has, as its primary feature, a check of the interchange track would require the taking of the initials and numbers of all cars interchanged direct from the cars themselves by the car checker, and checking this information against the interchange report as prepared by the interchange clerk from data secured from waybills or passing sheets. Practically it has been found that except at the larger yards where men are employed especially for the purpose of making the yard check, the agents used only the information shown on the waybills as the basis for their interchange reports. To add to the interchange sheet the car capacity information would increase the work of the yard checkers about one-third and the work of rendering the interchange reports about one-fifth, and as this information is used as a basis of settlements the correctness of the reports would have to be carefully verified in the central bureau, comparing there the capacity as reported on the interchange blanks with the listing shown in the Equipment Register, in itself a very considerable amount of work. As there are approximately 130,000 cars interchanged in the United States daily there would be a very substantial increase in the amount of clerical work required and, in addition, a slowing up in the handling of cars which the roads can ill afford.

2. The committee of 1909 believed strongly that a per diem rate once fixed should not be subject to sudden or rapid changes, which should be made only after careful and deliberate consideration.

3. It is well understood that the traffic volume is subject

to short and long swings. There is a marked seasonal difference between the heavy movement, in the months September to February, inclusive, and the light movement in the months March to August, inclusive, and there is a marked difference between the heavy movement of years of industrial prosperity and the light movement of the years of industrial adversity.

In times of unusual demand for transportation, it may be true economy for a road to pay a high price for sufficient cars to relieve a congestion which is incidentally or directly affecting business unfavorably, while even a comparatively low rate may be burdensome to pay for foreign cars when there are no paying loads to put in them.

In times of car surplusage it is urged that, in view of the empty mileage that would be avoided, the roads as a whole might be better off with no per diem charges; in times of car shortage a rate of 50 per cent above normal would not prevent roads taking cars as they needed them (see Figure 56).

It is a misfortune attaching to per diem that at times it has been sought to make it a source of profit, while to avoid it, all sorts of petty claims and undignified practices have been indulged in, and much wasteful movement of cars in yards and trains has resulted.

In times of car surplusage, arrangements have been made between connecting lines and groups of such lines under which the cars are stored where made empty and no per diem reckoned on them.

In times of car shortage schemes to avoid detention are pressed. Twenty-three different methods have been tried or proposed and were examined by the McCrea Commission. The same trouble exists in other parts of the world, and elsewhere as here the principle of imposing a penalty for failure to return a car to its owner is recognized. But the proof of guilt is difficult and excess of empty mileage is a harmful result.

Any marked variation from the normal car movement, whether because of lack or excess of business, causes an in-

crease in empty mileage and this is accentuated by the incidence of per diem.

170. Clearing House.—The successful working of a clearing house among the national banks in the larger cities and of the clearing house established by Hudson and Flynt January 2, 1842, for the English railways, has led to experimentation with the idea among the railroads of this country. From June, 1908, to May, 1912, the American Railway Association maintained a clearing house at Chicago for such roads as desired to use its facilities. The accounts of such members only were handled and settlements made on a balance basis as reported by the members. All settlements with private lines were handled by each road with the private lines direct. Neither did the bureau undertake to make settlements with the short lines and non-per-diem roads, leaving the members to maintain a small per diem force for that purpose, as well as to maintain the usual car record force to advise themselves of the interchange and location of cars on their own roads for other necessary transportation purposes.

The reasons put forward for abandoning the plan were the volume of work flowing into the clearing house and its inability to secure correct balances, and the consequent opposition of the higher accounting officers. It could not be taken for granted that the operations were correctly handled, so that in order to protect the railroads' revenues it was felt necessary to check the same and this involved labor that offset to a considerable extent that which it was supposed would be saved.

It has been suggested that if three or five bureaus had been established, advantageously located in the country instead of concentrating all the work in Chicago, there would have been a greater likelihood of the plan succeeding.

On April 10, 1919, the United States Railroad Administration established a car hire bureau at Buffalo for the purpose of dealing with settlements of passenger and freight car hire accounts between Canadian and United States roads and between Federal and non-Federal roads, including with

the latter Mexican roads. The experience of this bureau was not substantially different from that of the Chicago Clearing House. As there are approximately 130,000 cars interchanged in the United States daily, a central clearing house involves the handling of interchange reports for this movement, together with subsequent additions and deductions through correction reports.

171. Car Service Rules.—Prior to the establishment of car service rules in 1888, there was an agreement between railroads, whereby settlements for car hire were made upon a mileage basis. Freight cars leaving their owner's tracks for movement over other lines earned no more for the railroad owning them than the rental charge of three-quarter cent per mile run. When they were not moving they earned nothing.

A car might stand in a yard or on a siding of a road in which the owner had no interest for an indefinite period, while the railroad company owning it might be suffering for equipment to meet the requirements of its patrons. It might be used in local service on the holding road, and if the user was so inclined, no returns need be made to the owner for the service, there being no check on its movements after it left the home rails except a report of its delivery to another line, and many times this report was missing. If conductors failed to report a movement (as they did in many cases) the mileage made was never reported to the car owner, for the miles run were figured from the conductors' reports.

Scant attention was paid to the routing of cars. A car was placed for loading in any direction without regard to ownership; there was no penalty prescribed for diversion or other misuse of equipment.

Cars, in many instances, were off the owners' rails for a year or more and when returned might be in a worn out condition. The owner's compensation was the mileage proffered by such roads as had used the car.

The misuse of freight equipment continued to increase. It became apparent to those in charge of car records and accounting that some method should be adopted to relieve

the situation. It was decided that those in charge of car records and accounts should get together and discuss matters with a view to bettering conditions.

The first meeting of car accountants was held at Cleveland, Ohio, October 17, 1876, pursuant to a call made on September 30, 1876, by car accountants representing the L. S. & M. S., C. C. C. & I., Erie, C. H. & D., D. & M. and A. & G. W. R. R.'s, and endorsed by:

Charles Paine, General Superintendent, L. S. & M. S. Ry.
R. F. Smith, Acting General Manager, C. & P. R. R.
E. S. Flint, General Superintendent, C. C. C. & I. Ry.
P. D. Cooper, General Superintendent, A. & G. W. R. R.

Representatives of some 64 railroads and freight lines connected with railroads responded to the call, and letters were received from 21 railroads expressing their favor of the movement toward more uniformity in handling car service matters and a better understanding of the duties of those in charge of them.

Two more meetings were held; one at Indianapolis, Indiana, April 18, 1877, and the other at New York City, April 26, 1878, when a permanent organization was formed to be known as the "Railway Car Accountants' Association of the United States." A constitution and by-laws were adopted. The membership of the association continued to increase until all the principal railroads and fast freight lines in the United States and Canada were represented in it. Regular meetings of the association were held annually. Car service matters in all their phases were discussed and many recommendations toward improving the service were adopted.

The International Association of Car Accountants and Car Service Officers (originally "The Railway Car Accountants' Association of the U. S.") and the Railway Transportation Association (a similar organization) were consolidated under the name of "The International Association of Transportation and Car Accounting Officers" at the annual meetings of the two associations held at Washington,

D. C., May 24, 1904, and a constitution and by-laws adopted. The object of the association was the betterment of car service matters in general, furnishing information and making recommendations to the committee on car service of the American Railway Association.

In order to prevent misuse and to keep cars moving in a homeward direction after lading had been removed, various means were employed. Some roads had them reported to the officer in charge of car records for billing instructions; others used a small card which showed the junction point where car was received from a connection, with instructions to return car to that junction point. The card was either pasted or tacked on the body of the car. It was found unreliable as it was often removed by unauthorized persons or by the elements.

Local home-route cards were used by some roads, showing road received from, junction point and date received, and directing return of car to point received, this card to travel with the car until so returned. A duplex card, combining a card waybill and home-route card was also used by some; the card waybill being detached from the home-route card at destination of car, and the home-route card continuing with the car the same as the local home-route card.

The local home-route cards were used more successfully than the cards attached to the car, and continued in use until the continuous home-route card was adopted by the American Railway Association, which became effective July 1, 1916. Its usage was governed by Car Service Rule No. 19, which provided that a continuous home-route card, as prescribed by the A. R. A., must accompany each car from the owning line until its return thereto, the record of its passing from one road to another to be stamped on the card at the junction of such roads, no freight car of railroad ownership to be moved over lines other than of the owners without such a card, or authorized substitute card, accompanying it. The continuous home-route card was being used with fairly satisfactory results when it was suspended on

April 26, 1917, due to the partial pooling of freight equipment to meet war traffic emergencies by the American Railway Association's "War Board."

The first rules for settlement of interchange freight car service were adopted to take effect January 1, 1888, as between themselves, by the New York Central, West Shore, Erie, Pennsylvania, Philadelphia & Reading, Lehigh Valley and Baltimore & Ohio Railroads, as members of the Trunk Line Association. Other railroads agreed later to become parties to the agreement, so that about 30 roads had adopted the rule from January 1, 1888, and nine others from February 1, 1888. The rules provided for a combined per diem and mileage charge of 15 cents per diem and one-half cent per mile on eight-wheel cars, and one-half those rates on four-wheel cars.

This mixed plan was unsatisfactory and most of the member roads had withdrawn from the agreement by January 1, 1889, those remaining being of opinion that this plan was a step toward straight per diem, but they all shortly returned to mileage settlements and so continued until the per diem rules of the American Railway Association, providing a straight per diem rate for settlement, became effective on July 1, 1902.

For the most part, rules governing the use of freight cars have been separated into those applying to:

Cars owned by holding road
Cars owned by direct connections of holding road
Cars owned by indirect connections of holding road
Cars received in switching service

In general, they have provided that home cars should not be used for loading off line when suitable foreign cars were available; that cars belonging to direct connections should be loaded to or via the owning road; and those belonging to indirect connections should be loaded to the general territory served by the owning road, back haul on holding road, or delivery to switching lines being permitted

to obtain such loading; that cars in switching service should be returned to the long-haul line loaded or empty at the point delivered loaded. Since 1917, however, in the interest of flexibility, the switching line has been allowed the use of the car provided it could be used in accordance with the general rules governing use of cars owned by direct and indirect connections of holding road.

In framing the present car service rules the old method of returning a car home through "home route rights" over various lines for each individual car was done away with, and to prevent back-haul and circuitous movement in its return home, the present equalization of the interchange arrangement[1] was instituted whereby each road is entitled to deliver to the other as many cars as it receives, provided only they are moving in the direction of home. Such an arrangement should work much faster in getting cars home than the one previously in effect, and will be accompanied by more violent fluctuations in the per cent of empty mileage figures, but it is not expected that the movement will extend over so long a period, or that the mileage in total will be as great as under the previous method. This, however, is clearly a pioneer move and while there are many reasons to believe it should work to advantage, there are other features, principally its possible failure to have the car follow the natural flow of traffic that may defeat its other advantages. This latter may in some cases place a heavy empty mileage burden on lines delivering a large volume of outgoing loaded traffic which do not for any reason get their proportion of the returning loaded traffic and there is at present a growing feeling, especially among the long-haul lines, that they would like to define their responsibility for handling empty cars by confining it to cars previously handled loaded.

172. Embargoes.—The embargo is a measure intended temporarily to stop acceptance of freight from shippers at points of origin, in order to avoid congestion at destination

[1] This equalization arrangement was discontinued on July 1, 1921, and the former "home route rights" plan again adopted.

or at intermediate points, and may be divided into two classes:

1. *Individual*—As against a certain consignee or destination, to cover one commodity or all traffic, and
2. *General* —As against traffic for a specific territory, routed to or via one gateway or via all gateways into that territory.

For many years the railroads complained of congestion of traffic at certain points, caused to a great extent by the practice of some roads, mostly switching lines, of placing restrictions (embargoes) against the acceptance of freight from connections. Such lines would serve notice that only a limited amount of traffic would be accepted on a certain date. The next day notice would be given to increase the deliveries and again the next day to reduce the number of cars, so that the originating or intermediate carriers were obliged to hold back traffic until such time as the road placing restrictions was ready to accept. The necessity for some regulation or set of rules to govern such cases was very apparent.

For several years this detail of freight transportation was the subject of discussion at the meetings of the General Time Convention, the International Association of Car Accountants and others, it being agreed "that some means should be found by which such practices could be stopped or the offending road penalized." At a meeting of the General Time Convention held at New York City, April 11, 1888, the Committee on Car Mileage and Per Diem Rates recommended: "Whenever a railroad company gives notice to its connections that, for any reason, it cannot receive any specific traffic or empty foreign cars, such notice shall not be made to apply to shipments already in transit, or that may be billed within 24 hours of the time of such notice." No definite action was taken on this recommendation until October 7, 1890, when at a meeting held in New York, it was referred to the American Railway Association for consideration in the form of a resolution.

In 1898 the American Railway Association attempted to have a code of per diem rules adopted but without success. Efforts were continued along these lines for several years. A code of rules was finally adopted which, after being submitted to the membership roads, became effective on July 1, 1902. Under Rule 14 (now Rule 15), a road holding cars could make reclaim for per diem from the road refusing to accept them. Under Rule 15 (now Rule 16) a road having congestion or other disability which prevented its accepting traffic could relieve itself from the penalties of Rule 14. The method of embargoing traffic and responsibility for doing so were thus clearly indicated.

Nevertheless these rules were not entirely satisfactory owing to the method of handling embargoes between roads; that is, it was the practice for a road placing an embargo to notify its connections by telegraph or letter of the embargo issued. Its connections, to protect themselves, must in turn pass the restrictions on to their connections until finally all the railroads were supposed to have received and made the embargo effective. This method of transmission caused:

1. Much dispute as to who should be responsible for per diem on cars held.
2. Delay in placing the restrictions with road furthest away.
3. Duplication of information.
4. Traffic to be loaded, sometimes several days after embargo became effective.
5. Roads not interested to receive and encumber their files with useless notices.
6. Misinterpretation by outlying roads because of change in wording during transmission.
7. Often cancellations to be started (through the same channels) before original embargo had reached all roads.

Many suggestions were offered to correct these features. Several plans were tried by individual roads, but without uniformity in methods little improvement was shown. Some were in favor of establishing a central embargo bureau; others favored the grouping of railroads with a bureau for

each group; still others had no remedy to offer but emphatically stated the system in use was "radically inefficient, cumbersome, annoying, complicated and expensive."

With the outbreak of the war in August, 1914, and the abnormal traffic offered for movement overseas, the North Atlantic Ports became so congested, the issues of embargoes so voluminous, and the duplication so great, that shippers, consignees, and railroad agents could not and did not attempt to keep up with current embargoes. Shipments were accepted and forwarded in total disregard of them.

This resulted in congestion all over the country; accumulations of thousands of cars extended for miles back from New York, Boston, Philadelphia, Baltimore, etc.; the gateways at St. Louis, Pittsburgh, Chicago, Detroit, Buffalo and other points became blocked, and it was almost an impossibility to move cars, either loaded or empty.

Shippers, traffic associations, and railroad officials held meetings to devise some means of relieving the situation. Statements were made that "attempts to relieve congestion by declaration of so-called embargoes were impotent as a measure of traffic efficiency," and to resort to them "was like obstructing a drainage system in a time of freshet."

During this period some attempts were made to handle the traffic on permit system; that is, an absolute or general embargo was placed against traffic to or via a specific territory and, as fast as conditions would admit, permits were issued to allow movement of specific freight through the embargo. This system was no doubt abused, the larger shippers often securing permits at the expense of the little shipper, a discrimination that should and could have been avoided.

Following the entrance of the United States into the war, the railroads were taken under Federal control as of January 1, 1918, and the United States Railroad Administration with its many committees and bureaus attempted to straighten out the traffic tangle.

General Order No. C. S. 17, dated January 15, 1918, contained regulations governing the handling of embargoes.

The railroads of the United States and Canada were divided into zones, interchange of embargoes between railroads being handled through the medium of zone chairmen. Each road was to assign only competent and experienced employees to the handling of embargoes.

For the purpose of uniformity and to expedite transmission, a road was under the jurisdiction of but one zone. Instructions provided that each railroad transmit its embargoes, modifications, extensions, and cancellations to all zone chairmen, also to its local agents and non-subscriber roads. Embargoes received by zone chairmen were to be transmitted immediately to roads under their jurisdiction by telegraph, telephone, messenger, railroad or U. S. Mail, a road laying an embargo to be responsible for issuing to the zone chairmen, its own officials and agents. Various other rules were given, showing method of transmission and forms to be used, and a cipher code was provided for sending embargoes by telegraph.

Freight traffic committees were placed in charge of the North Atlantic Ports, Boston to Newport News, to control the handling of export, coastwise and domestic traffic via those ports.

Circular No. C. S. 1 was issued, February 11, and Circular No. C. S. 1-A on March 26, 1918, as supplements to General Order No. C. S. 17, both containing further instructions governing the handling of embargoes, permits, etc.

Circular No. C. S. 57 was issued, March 12, 1919, and canceled all previous instructions relating to embargoes. This circular changed the method of transmission. A road desiring to place an embargo was required to notify the regional director giving full explanation as to why same was necessary and what, if any, exceptions were desired. When approved by the regional director, he transmitted it to all federal controlled roads in his region, to the car service section, and to all regional directors and embargo bureaus interested, for transmission to roads under their jurisdiction. Each federal controlled road notified its own agents and non-federal controlled roads assigned to it.

On March 31, 1919, the Freight Traffic Committee, North Atlantic Ports, was disbanded and Traffic Control Managers appointed in its place, with much the same duties and authority.

Under the permit system the consignee and not the shipper was required to make application for permit to ship.

The system of handling embargoes under United States Railroad Administration was an improvement over the methods in force prior to Federal control but was far from satisfactory. Under circular No. C. S. 17, a road laying an embargo transmitted it to its connections through the Zone Chairman, causing considerable delay. Under Circular No. C. S. 57 it was necessary to get the approval of the regional director before an embargo could be made effective, a complicated and round-about manner of handling. Circular No. C. C. S. 5 of March 5, 1920, was an improvement over previous instructions.

Circular No. C. S. D. 87 issued October 5, 1920, by the car service division, American Railway Association, contains what is apparently the best method of handling embargoes so far devised, but is still susceptible of considerable betterment.

The car service division supervises the distribution of embargo notices between roads, the United States and Canada being divided into embargo districts and each railroad assigned to one district, each district being under the supervision of a district chairman who is responsible to the car service division for the proper handling and prompt transmission of embargo information. Each railroad may issue, as necessary, embargoes applying to traffic originating on or routed to or via its line.

A road placing, modifying, extending or canceling an embargo, immediately transmits a copy of such notice to:

1. The car service division.
2. The embargo chairman of district to which assigned.
3. The designated embargo officer of direct connections (unless inapplicable).
4. Its local agents and other representatives.
5. Its assigned short lines.

The district chairman will immediately transmit all embargoes received from all railroads in his district to:

1. All railroads in his district (except connections of issuing road).
2. All other district chairmen.

And all embargoes received from other district chairmen to:

1. All railroads in his district (unless inapplicable).

The instructions provide that freight loaded and billed prior to embargo becoming effective shall be accepted; that an embargo should not be placed on request of consignee; that consideration should be given to a permit system to avoid a complete embargo.

The handling of embargoes, as practiced under federal control and since, showed the old methods to have been not only wrong, cumbersome, expensive, and ineffectual, but a possible means of discrimination against a shipper or consignee. An embargo should be used for but one purpose, the temporary stopping of traffic to or through a certain point in order to avoid an accumulation or to enable a railroad to overcome congestion already established, to meet operating conditions only and not as a measure of convenience for a shipper or consignee. Whenever possible permits should be granted to cover specific tonnage, loaded on or before a specified date and to move via a certain route named in the permit. This will enable the embargoing road to anticipate the volume of traffic in sight at all times and to a great extent shorten the life of the embargo. On the other hand the embargo should not be restricted to shutting off the entire traffic of a line but freely used to restrict the movement of one commodity only or even to a single consignee.

173. Code of M. C. B. Rules.—Prior to 1864, railroad cars were confined almost, if not entirely, to the roads for which they were built and to which they belonged. Between 1864 and 1867, roads of the same gauge track began extensive interchange of cars to avoid breaking bulk and the inconvenience,

expense and delay of trans-shipping freight from the car of one railroad to that of another at the junction points. This brought into existence different express, or fast freight, lines operating over two or more roads.

Handling the cars in this manner soon made it plain that some set of rules was necessary to govern the interchange and repairs of same, and at Chicago, December 14-15, 1876, a code of rules covering freight car interchange was adopted by the Master Car Builders' Association. Prior to this date there were only special agreements between roads interested in the different fast freight lines. The code of rules adopted was very brief and did no more than cover the bare necessity of interchanging cars. These rules were first printed in booklet form by the Master Car Builders' Association in 1887. Prior to that date they were printed in the proceedings of the Association, and in pamphlet form by the Railway Age Gazette.

In 1879 rules for settlement for destroyed cars were adopted. Prior to that time destroyed cars were settled for on the replacement basis, less depreciation due to age. The rules, as adopted in 1879, provided for an arbitrary settlement for the different classes of cars and this practice prevailed until 1913 when for a short period settlement was on the basis of book values. The practice of settling on the basis of book values did not work out very well because of variation in methods of bookkeeping in vogue at the time the older cars were acquired. In 1914, the practice of settling for cars destroyed on an arbitrary basis was restored for cars built prior to October 1, 1914, and for cars built subsequent to that date, settlement was on the basis of book values. This practice prevailed until 1920 when the rules were again changed to provide for settlement on the per pound price. An exception covered refrigerator, special stock cars, and cars constructed for other special purposes, which have been settled for on the replacement basis since 1886.

In 1880, to cover responsibility for defects existing on cars interchanged where the delivering line did not have shop facilities at the interchange point to make repairs, and the

car was safe to move, the practice of defect carding was first adopted and this practice still exists.

Up to the year 1890, the tendency of the rules was to make the handling line responsible for as much as possible, other than ordinary wear and tear, and since that date the tendencies have been to make the owner responsible for as much as possible.

From the beginning of the practice of interchanging freight cars, disputes have continuously arisen as to the cause of damage, and the responsibility, to equipment on account of rough handling by the carrier in whose possession the car was damaged, and in 1886 combinations of simultaneous damage were adopted defining rough usage as mentioned above. When the steel underframe car and the all-steel car began to be used extensively, difficulty arose in defining the application of the above mentioned combination rules to those classes of cars, but the combination defects were continued for wooden cars until the year 1918. It was felt that this undue protection given to the wooden car of more or less obsolete design kept it in use; removal of this protection, which was not accorded to the steel underframe and all-steel cars, it was felt would encourage the building of the latter classes of cars.

In 1918 the general rules covering combination defects and responsibility for cars unfairly handled were consolidated into Rule 32 and Rule 43, which though amplified have remained substantially unchanged. At the present time, however, the matter does not seem to have been altogether satisfactorily covered; there is a considerable variance of opinion as to the interpretation of the present Rule 32 covering delivering or handling company's responsibility for damaged cars, and Rule 43 covering owner's responsibility, and it should be made the subject of a special committee to redraft these rules.

In the early part of 1917 a joint committee was appointed by the American Railway Association and the Master Car Builders' Association to investigate the practice of billing for car repairs. One of the results was the adoption of the

original record of repairs. Prior to that time there was no standard method of making or preserving the original record of repairs, which is absolutely necessary for the purpose of checking.

When one considers that there are approximately 2,500,000 freight cars moving freely over the country and that over $245,000,000 is spent yearly by railroads of the United States for repairs to their freight cars on other railroads' lines, and that this enormous sum is exchanged between railroads without any definite means of checking against the actual work performed on the car, one appreciates the importance of having standard original record of repairs and why railroads are now insisting upon full and clear original records of repairs with the reason for each item.

The labor rate per hour as given in the rules prior to the issuance of the 1920 rules, effective November 1, 1920, has been based on the average rate per hour paid to carmen throughout the United States, and to this was added a percentage covering part of the overhead expenses, but this did not take into consideration any allowance for interest on investment, depreciation, taxes, insurance, maintenance of shop buildings, repair to tracks, etc., so that in reality up to November 1, 1920, the labor allowance per hour did not cover the amount expended by the repairing road.

While all railroads are presumed to give foreign cars on their line the same care as to inspection and repairs as they give their own, regardless of the responsibility for the expense of repairs, the presumption is not always justified by the fact. The handling line, generally speaking, repairs foreign cars only to the extent of safe handling to commodity and trainmen over their line. There is no incentive to go further, really at the expense of the handling line, even though the repairs may be chargeable to the owners. This may be one of the reasons for the uneven distribution of the burden of repairs and the lack of better facilities for repairs.

When a car is sent from the transportation or classification yard to a repair track, an average of at least three

days is consumed before it is again returned to a classification yard ready for use and during this time the handling road has paid three dollars per diem for the use of the car, thereby consuming a large percentage of the amount it is entitled to collect from the owner. Perhaps if the handling line were allowed to add a profit of, say, 10 or 15 per cent to its bill against the owner, and if per diem charges could be cut on cars shopped for repairs to owner's defects, where the labor charge for the owner's defects under the rules amounted to, say, 24 or 48 hours, there would be an approach toward the equalization of the burden of freight car maintenance and an incentive for handling lines to give foreign cars better attention and create better facilities for repairs. It is true that more profit would accrue to the roads which have adequate facilities for repairs than to roads not so well equipped, but the cutting of per diem as mentioned above would not work a hardship, in loss of revenue, to the roads that properly maintain their own equipment.

174. Car Ownership.—At the base of all these troubles lies the lack of any definition of the responsibility of the roads in the furnishing of cars.

Each road owes a duty to the community that it serves to provide cars in quality and reasonable quantity for the local business of the community and the railroad; also to provide its pro rata share of the cars necessary for the proper development of business exchanged between the road and the community served by it, and between other roads and other communities. Under the general practice built up by the carriers through rates are freely made, extending in all directions to all parts of the country, contemplating, and indeed compelling, cars to go through to destination without transfer, resulting in a condition in which the cars are used much as though they were in a "limited pool." No plan can ignore the fact that the internal commerce of the country has been built upon the relatively free circulation of equipment in the joint interest. Were the relative car contributions of the roads determined and enforced, then a low per diem rate would tend to avoid unnecessary empty

movement, large in times of car shortage, greatly increased during the period of relocation of equipment in passing from times of commercial activity to times of commercial depression, and encouraged by the temptation to use cars for the purpose of making per diem earnings when they are plenty. As an effort in this direction Julius Kruttschnitt and I secured a seasonal per diem that was in effect from August 1, 1910, to December 31, 1912, under which the rate was 30 cents per day for the months of March to July, inclusive, and 35 cents per day for the months of August to February, inclusive. It seemed to work very well at the time and the idea might be given further consideration in discussions of the subject.

The initial pressure to furnish equipment is brought by the man offering the shipment and in the main the roads originating business have provided themselves with the type of cars adapted to the business offered. They have not done so well in the number of cars provided. Several rules have been suggested to define the responsibility of the roads.

The Interstate Commerce Commission, in the case of the Huerfano Coal Company *v.* Colorado and Southeastern Railroad Company (28 I. C. C. Reports 502, 506) defined the obligation to be that a railroad "must provide such a supply of cars as would be sufficient to enable it to perform its part therein if there were car-for-car interchange at its junctions."

This of course ignores (*a*) the variation in the types of cars interchanged, which, however, is likely to be unimportant except in special instances; (*b*) the carrying capacity of the cars interchanged, which may, at the present time, make an interchange on the unit basis very unequal if the comparison is made on a "tons per loaded car" basis, and (*c*) the relative distance moved over the lines participating in the movement. Roughly speaking, a road 2,000 miles in length requires three or four times as many days to handle a freight car over its lines as a road 500 miles in length.

This last consideration was given weight by the Board of Railway Commissioners of Canada in their General Order No. 176, relating to coal movement, issued December 26, 1916;

For all movements requiring transportation over more than one line, the company that enjoys the longer portion of the haul shall supply the cars, and in case such company is unable to supply the cars, then the other company, although only obtaining earnings for the movement over the shorter portion of the haul involved, shall supply the cars, but in such case shall be entitled to be paid by the company enjoying the longer haul, a per diem charge of $1.25 for each and every car so supplied, instead of the usual per diem charge (then 75 cents) and any increases thereof that may be made less than the said sum of $1.25, the said charge to run from the time such cars leave until they are returned to the line of the owning company.

This rule fails to give effect to the intimate relations and mutual knowledge and interest of the originating road and its shippers. No rule which relieves the originating road from responsibility for furnishing cars on which it receives a road haul (as distinguished from what is in fact merely a switching service) is likely to succeed, so far as it relates to the transportation of commodities requiring the ownership of, say, 500 cars or more on the part of the originating line to transport it to market destinations. Such a road must assume the full responsibility for furnishing cars. Its connections should supply such a proportion of the cars generally needed as to insure the prompt movement of all the traffic at times of greatest activity. At such times every carrier takes the position that its first duty is to its own patrons and the traffic in which they have a special interest, to discharge its obligations to the territory directly served, and to use the remainder only of its facilities, equipment, etc., for the general advantage of the road. On the other hand, they will feel that it is their privilege to keep this equipment working in preference to that of "pass over" or "distributing" lines, which experience has shown cannot be relied upon for contributing effort in periods of heavy traffic.

Several suggestions and formulae have been made to define the responsibility of the various carriers in furnishing equipment, both locally and as a part of a through line; so far, none put forward is thought to stand the test of

successful application, and this is perhaps to some degree due to the lack of respect by the railroads for the obligations they have mutually assumed in the handling of car equipment. The success of such formulae depends too much upon the varying general demand for cars, the desirability of the traffic, and the extent to which each road has immediate interest in the use of its equipment. The traffic exigencies in the end exert the controlling influence.

In the eastern region the suggestion of J. W. Roberts, General Superintendent Transportation, Pennsylvania Railroad, has been found to check fairly well against the facts and is as follows:

1. Determine the average number of cars of each class on the lines of a railroad *daily* during each of not less than twelve (12) months within which the supply of cars available for distribution among local orders was insufficient to meet such demands, by dividing the sum of the number of cars on lines of each of two (2) days, namely, the 1st and 15th of each month as shown by location statements, by the number of location statements involved.
2. Determine the daily shortage of each class of cars on lines of railroad, during the period to which result obtained by employment of Detail 1 of formula applies, by subtracting from the average number of cars required daily to apply on local orders the average number of cars furnished daily as indicated by car distribution record, and multiplying that result by the average time (per car) required for complete movements of cars of the class involved, applied on local orders.
3. Add the result obtained by employing Detail 1 to result obtained by employing Detail 2 of the formula.
4. Combine results for different classes of cars obtained by employment of Detail 3 of formula, to determine the total number of freight cars which should be owned (or controlled otherwise).

Application of formula to one railroad and to one class of cars:

(*a*) Average number of box cars on the lines of Railroad "A" during each of twelve (12) months within which car shortages obtained..	16,000
(*b*) Average number of cars required daily to fill local orders during the period referred to in Item (*a*)	600

(*c*) Average number of cars available daily to apply on local orders referred to in Item (*b*)...	400
(*d*) Average daily shortage of cars to apply on local orders per Item (*b*)..................	200
(*e*) Average time (days) per car required for complete movement of cars applied on local orders, per Item (*b*)............................	7
(*f*) Average number of cars which should have been on the lines daily to have completely satisfied local orders, per Item (*b*) (7 days × 200 cars)	1,400
(*g*) Total number of cars required to meet the full demand of commerce (16,000 plus 1,400)....	17,400

5. If the remainder obtained by subtracting an average surplus of empty cars on lines daily during a period of not less than twelve (12) months from the average total number of such cars on lines daily during the same period is a number less than the number of cars owned, the number of cars owned is excessive.

Conversely, if the remainder so obtained is a number greater than the number of cars owned, the number of cars owned is deficient.

EXAMPLES

Excessive ownership

(*a*) Number of box cars owned...............	1000
(*b*) Average number of box cars on lines daily during a period of not less than twelve (12) months..............................	1200
(*c*) Average surplus of empty box cars on lines daily during the period referred to in Item(*b*)	300
(1200–300), 900 (cars in excess of proper (1000–900), 100 quota)	

Deficient ownership

(*a*) Number of box cars owned..............	1000
(*b*) Average number of cars on lines daily during a period of not less than twelve (12) months	1500
(*c*) Average surplus of cars on lines daily during the period referred to in Item (*b*)..........	300
(1500–300), 1,200 } (cars in deficit of (1200–1000), 200 } proper quota)	

Pursuant to a resolution of the Association of Railway Executives, on July 1, 1920, the Advisory Committee of that

body had prepared a report on "the number of ears each railroad should provide, divided into classes of open, box, refrigerator, stock cars, etc. This information, compared with what they have provided, will show to what extent each carrier has fulfilled its duty."

The committee classified the roads into originating, delivering and bridge or pass-over lines, and terminal, or belt, companies and short lines, and considered the matter under four prevailing principles, it being agreed that the originating and delivering roads only should be obligated to furnish equipment. About four per cent of the total stock of cars are in use constantly on terminal lines, belt lines, short lines, industrial railroads, etc.

(*a*) The debit balance of per diem for each class of equipment. This would concentrate new purchases in the debtor roads.

The Bureau of Railway Economics has very kindly prepared for me statements of the hire of equipment balances of the Class I roads for the years 1908–1919, both inclusive (see Figure 57). While these figures include also hire of locomotives, passenger cars, work and floating equipment, and so affect the gross amounts, the proportions are such that the amounts stated seem fairly to reflect the balance of rentals for freight car equipment alone. These records show that of the 182 railroads, 54 were in 1919 actually, and for the other years generally, creditor roads; that 67 railroads were debit roads paying rentals in sums less than $100,000; that 34 were debit railroads paying rentals in amounts between $100,000 and $500,000, while 27 were debit railroads paying rentals in excess of $500,000, and in an amount equal to 81 per cent of the whole. Of the $35,100,-080 debit balance, 14 roads paying rentals in excess of $1,000,000, each paid in the aggregate $20,771,840, or 59.2 per cent of the whole. These debtor roads should supply themselves with 104,944 additional cars as the growth of the traffic requires increase in equipment, and until that is done the creditor roads should buy no more cars.

By way of an aside I may suggest that a study of Figure

57 shows that except for the period of the war, when there was an abnormal eastbound movement and business banked up at the Atlantic ports awaiting ships, the complaint so often made by the Western Lines of abuse of their equipment by the Eastern Lines is not justified. In the six years, 1908-1913, both inclusive, the debit of the Eastern Lines was $49,067,978, of the Western Lines $46,072,507, while the credit of the Southern Lines was $10,404,248. Interpreting these figures in the light of such knowledge as we have of the matter it seems likely that the east paid the west an excess of perhaps 10 per cent on balance. Certainly this was amply made up in the superiority of the cars the east contributed as well as in their excess carrying capacity.

FIG. 57.—CLASS I ROADS—UNITED STATES

Hire of Equipment—Net Balance[1]

	Years.	Eastern	Southern	Western	United States
(Fiscal year).......	1908	Dr. $3,815,233	$1,119,720	Dr. $4,042,778	Dr. $6,738,291
" "	1909	Dr. 10,011,952	557,573	Dr. 5,802,888	Dr. 15,257,267
" "	1910	Dr. 7,408,633	2,560,022	Dr. 9,201,767	Dr. 14,050,378
" "	1911	Dr. 9,331,256	2,029,106	Dr. 10,335,897	Dr. 17,638,047
" "	1912	Dr. 9,185,632	1,217,137	Dr. 8,331,957	Dr. 16,300,452
" "	1913	Dr. 9,315,272	2,920,690	Dr. 8,357,120	Dr. 14,751,702
" "	1914	Dr. 12,124,701	2,046,489	Dr. 5,260,494	Dr. 15,338,706
" "	1915	Dr. 13,342,172	1,783,447	Dr. 5,514,539	Dr. 17,073,264
" "	1916	Dr. 22,279,165	4,551,240	Dr. 3,651,208	Dr. 21,379,133
(Calendar year)....	1916	Dr. 26,390,184	8,113,815	Dr. 2,727,985	Dr. 21,004,354
" "	1917	Dr. 32,631,763	13,897,783	49,510	Dr. 18,684,470
" "	1918	Dr. 18,025,884	1,760,781	3,122,654	Dr. 13,142,449
" "	1919	Dr. 17,810,079	Dr. 594,961	Dr. 16,695,040	Dr. 35,100,080

[1] Years 1908 to 1914, inclusive, cover all equipment. Years 1915 to 1919, inclusive, cover freight cars only. Latter figures not obtainable prior to 1915.

Neither does a review of the incidence of per diem earnings bear out what the committee describes as the "disadvantage and perhaps impossibilities" of using as a basis of determining the obligation of ownership the per diem debit balances; on the contrary, the large debits are fixed upon the large originating roads.

(*b*) Past practices: As the purpose was to correct abuses due to past practices, they could be availed of only as disclosing the full details of the things to be corrected.

(*c*) On a combination of originating tonnage and per diem balance.

In 1918 the Interstate Commerce Commission reports show:

Tons of freight originated	1,263,265,890
Revenue cars owned	2,323,262
Tons handled per car per year	548
Tons per car, average load	26.6
Times per car loaded in year	20.6
Time required for round trip, days	17.8
Average daily tonnage	3,461,002
Average number of cars used daily to handle tonnage originated	130,112

Were the ownership of cars to be fixed upon the basis of tonnage originated, 17.8 cars would be required for each car of freight originated daily supposing it to be loaded at the average of 26.6 tons per car.

Giving weight to the matters affecting the movement:

1. (*a*) Ratio between traffic originated and handled varying with the originating road, delivering road, bridge road.
   (*b*) A differential where tonnage originated is predominant in any one commodity.
2. The movement of the cars (miles per car per day).
3. Loading per car.
4. Other items of operating efficiency.

The committee concluded that "when, generally speaking, traffic conditions are equal or on an average, or when not influenced by an unusual proportion of some single or group of commodities, such as coal, ore, or steel, a fair proportion of per diem balance may be said to be that with 90 per cent, or 75 per cent of cars owned for the originating, and 110 per cent, or 125 per cent, for the receiving line, the business of the various lines should be handled without car shortage. . . . If a road owns sufficient equipment to care for tonnage originated in turning time of 17.8 days and has less than 90 per cent general, or 75 per cent special, equipment on line, its quota may for present purposes be considered as having been filled."

The committee submitted the following formula:

1. (*a*) Determine class of road:
   (1) Bridge.
   (2) Originating.
   (3) Delivering.
   (*b*) Develop any predominating traffic conditions.
2. Figure cars owned to each car loaded and determine whether short of, or over, average.
3. If short, how much, per car loaded.
4. Per diem balance—apply the difference above 90 per cent (or 75 per cent) or 110 per cent, as the case may be, as a percentage increase in total responsibility.
   Where tonnage originated, as applied to present ownership of cars, and the per diem balance both indicate a road to be short of its ownership requirements, other things being equal, that measure which is the higher will be considered as applicable. Frequently special factors may influence conclusions.
5. Determine, if practicable, whether any special feature, such as:
   Traffic increases.
   Bad order.
   Slow movements.
   Light loading.
   Capacity and condition of present ownership, affect conditions and apply in general conclusions.

All these discussions, and the formula itself, ignore the variety of practice in the carrying capacity of the cars and the difference that may obtain in the length of line, though this last is subject to some correction.

The committee also discussed the question of special equipment, and the formation of car holding companies and pointed out that while there are numerous matters to be solved in such an arrangement, there are also many advantages, among which are the following:

(*a*) Avoidance of the necessity of undertaking to compel a particular line to increase its equipment.
(*b*) The creation of a floating volume of equipment, transferale in accordance with the requirements of traffic.
(*c*) Advantage of a supply of cars, increasing flexibility in car

handling, as such cars will not be found by Car Service Rules. This appeals directly to shippers.

(*d*) The formation of a common-owned nucleus which can be increased from year to year, in accordance with the necessities and as part or all of the railroads may elect thereafter.

(*e*) While it is realized that a special inspection force may be required to supervise the arrangements with the various railroads for heavy repairs and rebuilding, these common-owned cars operating in a pool will offer the advantages of possibility of maximum use. They will effect reduction in capital investment for transportation, together with transportation advantages and economy from the use of pool cars. Efficiency in the use of Pullman equipment, and particularly refrigerators, under present handling is emphasis of the actual advantages from such method of operation.

From a consideration of the several suggestions above set forth, and of the general interests of the traders and the railroads, it would seem that the matter might be approached along the following lines:

1. The terminal lines, belt lines, short lines and industrials using about four per cent of the car equipment may be relieved of any obligation to furnish them, except that industrial roads should furnish cars for the industrial service of their owners, and the more important terminal and belt lines for their fuel coal supply.
2. Where the originating line is offered by its shippers traffic of a special seasonal character that will not annually employ in its transport the use of at least 500 cars, the originating line will not be required to furnish such cars but may call upon its connections for them. There is among both transportation and traffic officers a recognition of cases that would require the uneconomical provision of equipment by the originating line to meet a special line of seasonal or unusual traffic, and a genuinely coöperative spirit is evident to meet such situations.
3. Where there is a demand for special equipment of unusual character, such as cable cradles, gun carriages, etc., the originating line should furnish the equipment.
4. Holding companies should be formed to handle special equipment for traffic requiring refrigeration or ventilation in large well-defined regions, as the California citrus fruit business, the Florida green vegetable business, etc., the investment to be roughly proportional to the mileage made on the contributing roads.

5. The 67 lines paying less than $100,000 on debit balance could probably equalize their position by providing themselves with a standard form of open top equipment to be used, for the most part, in handling their fuel coal. To the extent that this will not substantially redress the situation of the 34 lines paying debit balances of from $100,000 to $500,000, and as to the remaining 27 lines, they should provide themselves with the additional equipment needed as indicated by their originating tonnage.

After the situation had been brought into balance along these lines, and sufficient experience had been had under it, it should again be reviewed, full statistical information having meanwhile been collected. While there is no direct relation between the revenue to be derived by its owner from the rental of a car and that which may be obtained from its earnings as a vehicle of transportation, yet its commercial value for purposes of traffic is the primary reason for its existence.

The profit may be lost if the car is not on hand when needed to supply the transportation, and this loss may be exaggerated by the fact that a car belonging to the owner of the line, which has lost the freight earnings, may actually be in the possession of a rival road, and thus be used to secure a profit which rightfully should have come to the owner.

The longer a car is away from home when business is good, the greater is the probability of loss of such traffic to the owner.

In the consideration of such matters can anything be added to what has already been so well said in other connections?

As for me, I, myself, have now for a long time ceased to look for anything more beautiful in the world, or more interesting, than the truth; or at least, than the effort one is able to make towards the truth.

PART VI

MOVEMENT OF ENGINES AND TRAINS

Now the gist of the thing is this:
Be silent, be calm, be alert;
Be there on the day,
And precisely, exactly, obey.

ANONYMOUS.

THOMAS NEWCOMEN

1663–1729

NO PORTRAIT IS KNOWN TO EXIST

JAMES WATT
(1736–1819)

RICHARD TREVITHICK
(1771–1863)

ROBERT FULTON
(1765–1815)
From a self-portrait in the possession of L. F. Loree

GEORGE STEPHENSON
(1781–1848)

FIGURE 58.—THE PIONEERS OF STEAM ENGINEERING.

PART VI

MOVEMENT OF ENGINES AND TRAINS

175. Development of Steam Transport.—The importance of an adequate appreciation of the modernity, the magnitude and the significance to us of the development of steam transport would seem to justify a brief review of its genesis. Dr. Dionysius Lardner points out in his book *Railway Economy*, that under Julius Caesar, 100 B.C.–44 B.C., communication was made by paved roads between the capital of the empire and the chief towns. These colossal works were not paths rudely prepared for the action of the feet of horses and the wheels of carriages by merely removing the natural asperities from the surface of the soil; they were constructed, on the contrary, on principles in some respects as sound and scientific as those which modern engineering has supplied—forests were felled, mountains excavated, hills leveled, valleys filled up, chasms and rivers spanned by bridges, and marshes drained, to an extent which would suffer little by comparison with the operations of our great roads of modern times. On the fall of the empire, they were, for the most part, destroyed.

Arthur Young, who traveled in Lancashire near the close of the eighteenth century, says:

> I know not in the whole range of language terms sufficiently expressive to describe this infernal road. Let me most seriously caution all travelers who may accidentally propose to travel this terrible country to avoid it as they would the devil, for a thousand to one they break their necks or their limbs by overthrows or breakings down. They will here meet with ruts, which I actually measured four feet deep, and floating with mud, only from a wet Summer. What, therefore, must it be after Winter? The only mending it receives is tumbling in some loose stones which serve no other purpose than jolting a carriage in the most intolerable manner.

In 1763 there was but one stage coach between Edinburgh and London. This started once a month from each of these cities. It took a fortnight to perform its journey.

Even so late as 1750 almost the whole land-carriage of Scotland, and of several parts of England, was conveyed on the backs of pack-horses. A moderate-sized horse would weigh about 1000 weight (1120 pounds). We may reckon his muscular exertion divided into eight parts, seven of which are required to urge his own weight forward and one that of the load. A horse of average force, working for eight or ten hours per day, cannot transport on his back more than 200 weight (224 pounds) and he can carry this at the rate of 25 miles a day over an average level country. Where goods were transported by wagon the speed was not only intolerably slow but so expensive as to exclude every object except manufactured articles of light weight and small bulk in proportion to their value. The experience of carters showed that in wagon transport over the better roads a horse must be allowed for each ton of goods transported and that with this power a wagon may travel 20 miles a day. The carter between Selkirk and Edinburgh, a distance of 38 miles, required a fortnight for his going and returning, while the rate between Liverpool and Manchester was 40 shillings a ton, or 15 pence per ton mile.

In the coal districts eight bolls of coal, equal to 1700 weight (1904 pounds) was the regular load for a horse with a cart, or wain, upon the common roads.

The introduction of railroads as a substitute for common roads at New Castle-on-Tyne took place between the years 1602–1649, probably a considerable time prior to the latter period. By 1750 there was scarcely an important mine but had its accompanying railroad. The most of the railroads descended in the direction the goods were to be conveyed, affording an easy draft to loaded carriages, and the descent was never so great but the empty carriages could be easily drawn up the acclivities, see Figure 59. The only motive power for a long time after the introduction of railroads was horses, and as long as the wooden rail continued in use, the general

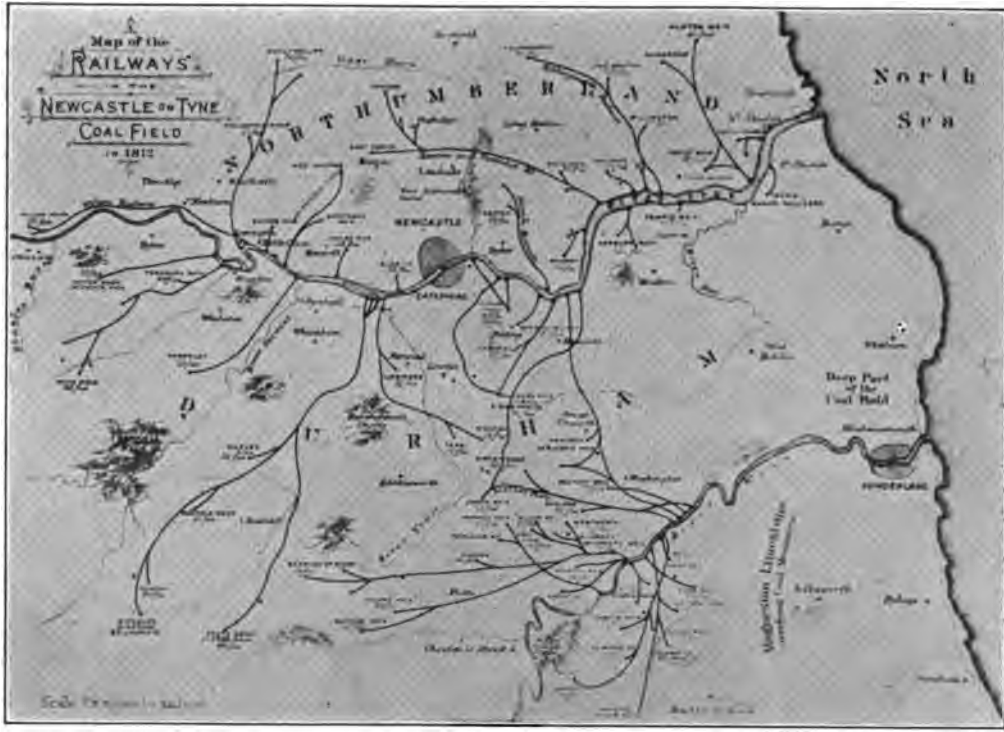

Map of the
RAILWAYS
NEWCASTLE on TYNE
COAL FIELD
in 1812
North
Sea
NORTHUMBERLAND
NEWCASTLE
DURHAM
Deep Part
of the
Coal Field
SUNDERLAND

FIG. 59.

load for one horse was 19 bolls, or 4200 weight (4704 pounds). When the wood-way was plated with iron, a horse was enabled to take a chauldron-wagon, containing 5300 weight (5936 pounds) of coals, exclusive of the weight of the wagons.

The next improvement was the adoption of iron rails (about 1767) when the load of the horse was increased to nearly double the quantity heretofore taken upon the wooden rail (or to say 9400 pounds) which also led to a complete change in the disposition of the road.

In 1789 William Jessop made a wonderful forward step by abandoning the flanged rail and bringing in the flanged wheel.

The history of the arts and manufactures affords no example of any invention, the credit for which has been claimed by so many different individuals and nations, as that of the steam engine. The account which follows has been compiled from a variety of sources, but I have relied largely upon the authoritative work of R. L. Galloway, *The Steam Engine and its Workings.*

The use of steam power definitely marks the transition from the old to the new industrial relation. The efforts to give practicality to a philosophical idea were pursued over a long series of years by many talented and skillful men, but among them all are recognized as outstanding the names of Newcomen, Watt, Trevithick, Fulton and Stephenson.

The use of a vacuum in lifting water as employed in the common suction pump had been understood from the earliest times and the action was explained by the dogma that "nature abhors a vacuum." That the air is possessed of weight, was, until comparatively modern times, unknown even to the philosophers. Galileo seems to have been the first to understand it and after his death in 1641 his pupil, Torricelli, continued his experiments and determined its weight by balancing mercury in a vacuum tube. The discovery excited wide interest and, in 1650, Otto Van Guericke invented an air-pump for the purpose of producing a vacuum. The scientific method of study by means of observation and

experiment was then obtaining many zealous adherents and the possibility of utilizing this new force for useful work received much attention.

The cylinder and piston, now so familiar, was, from the first, the favorite apparatus for experiment. Hugghens, in 1678, exploded gun powder to produce a vacuum under the piston, allowing the atmospheric pressure above the piston to perform its work. He got no further than to lift some 1600 pounds to the height of five or six feet by the explosion of a small quantity of gun powder, enough to fill a thimble. The difficulty lay in obtaining a continual repetition of the force. Papin, an assistant of Hugghens, after many ineffectual trials of gun power, undertook to produce the vacuum by the use of steam. Papin was able to demonstrate a great principle though he produced no useful machine, but from his time the engine ceased to be a gun powder-and-air-engine and became a steam-and-air-engine. With this came a further change. The speculations of the philosophers had put men of another class—workers in brass and iron—in possession of the scientific principles upon which a new motive engine might be constructed.

Thomas Savary, a military engineer, had designed a fire engine using the expansive force of steam to produce the vacuum upon which he had obtained basic patents on July 25, 1698, running for 35 years, and from which he expected great things as a mine-draining machine. It did not, however, fulfill expectations.

176. *Newcomen.*—Thomas Newcomen was a native of Dartmouth in Devon. He renewed the development of the atmospheric engine and brought forward his improvements under the protection of the Savary patent, though the machines were of wholly different classes.

Having given several years to the perfecting of the engine, he installed one near Dudley Castle, Wolverhampton, in 1712, engravings of which are still in existence. The cylinder was a large air-pump barrel made of brass; the piston a circular brass disc on the upper side of which a leather flap was secured, kept soft and air-tight by means of water, a few

inches in depth, lying constantly upon it. The engine actuated a gigantic pump handle or working-beam which communicated the pull of the piston to the pump rods; the weight of the pump-rods in turn brought back the piston to the top of the cylinder, on the admission of steam below, placing it in equilibrium. To lift the piston fresh steam was introduced below it at every stroke of the engine to be in turn condensed by the introduction of cold water into the inside of the cylinder. The condensing water and the water of condensation were drawn off through a sinking or *eduction pipe* issuing from the bottom of the cylinder. To prevent *wind-logging* through accumulation of air in the cylinder, a *snifting-valve* (so named from the noise it made) was applied, which, opening upwards, and sitting in a little cup filled with water, admitted of air being blown out while preventing the entrance of external air. A self-acting gear made the engine to work entirely by itself. In working, on the piston arriving at the top of its stroke, the *regulator* or steam-valve required to be closed, and the injection-cock to be opened immediately afterwards. A vacuum was then formed by the condensation of the steam, and the piston was driven down to the bottom of the cylinder (open at the top end) by the pressure of the atmosphere. As the piston arrived near the end of the down-stroke the injection-cock required to be closed and the regulator to be opened immediately afterwards, whereupon, steam being admitted into the cylinder, the piston was placed in equilibrium, and the weight of the pump-rods in the pit brought it again to the top of the cylinder, and this was affected by a buoy-apparatus that continued to be used for many years. The engine near Dudley Castle is stated to have made 12 strokes a minute, and to have raised 10 gallons per stroke from a depth of 150 feet. The pumps were in two lifts of 75 feet each.

This cylinder and piston engine, the invention of Newcomen, though marketed under Savary's patent, combined power and safety in a remarkable degree. The mine operators quickly appreciated its advantages and a few years saw it in use for draining mines in all parts of the Kingdom. It

was now possible to open up and work, by the help of these engines, collieries which could not be worked before.

Newcomen is stated to have died of a fever in London in 1729, after a fortnight's illness. He had lived to see his invention widely introduced, and on all occasions with the greatest success. He would doubtless have received more of the preëminent distinction to which he was entitled during his lifetime, had he not acquiesced in his great invention being allowed to pass for an improvement upon Savary's engine.

Henry Beighton, an engineer, constructed a table of dimensions of engines for raising water from given depths, modifying some of the arrangements of the machine itself.

John Smeaton, the celebrated civil engineer, conducted a series of experiments, from which he deduced rules for the best proportions of the parts of atmospheric engines, and, in 1772, he constructed a table embodying the results, and giving the best proportions for engines of all sizes up to 72 inch cylinders, with a special view towards promoting economy of steam.

As regards the machine itself, its mechanism remained almost exactly in the condition given to it by Newcomen, until the date of its transformation into the modern steam engine by the genius of Watt. During this interval, however, great changes occurred in the materials used in the construction of the engine and its appendages; its size was largely increased; its use much extended. Being single-acting, little success attended the various efforts which were made to derive a rotary motion from the reciprocating movement of the engine.

By 1770 more than 100 engines had been installed at collieries in the Newcastle-on-Tyne district, and, while many had worn out and been given up, 57 were working. Some 60 engines had been installed in the metalliferous mines of Cornwall, the excise tax on coal having been remitted.

Smeaton computed that 5,590,000 pounds of water were raised one foot by the consumption of one bushel (84 pounds) of coal. His improved engine is stated to have raised 9,450,-

000 pounds one foot by the consumption of a bushel (84 pounds) of coal. One that he built for installation at Chacewater, Cornwall, had a cylinder 72 inches in diameter, worked with a nine-foot stroke, and made nine strokes per minute. The average pressure on the piston was 6.72 pounds per square inch. It had three boilers, each 15 feet in diameter, one placed beneath the cylinder and one on each side of the engine-house. The working-beam of this engine was built of 20 fir beams, two in width and ten in depth.

177. *Watt.*—James Watt was born at Greenock, in Scotland, on January 19, 1736. Educated in the academies of his native town, at 18 he went to Glasgow to learn the trade of a mathematical instrument maker; after a year he went to London where he worked for a year, returning to Glasgow in August, 1756. Being neither the son of a burgess nor having served a regular apprenticeship, he was prohibited from setting up a workshop within the city limits, but finally opened one within the college enclosure and became "mathematical instrument maker to the University." In the winter of 1763 he was given for repairs a small working model of Newcomen's engine. The boiler, though apparently quite large enough, was unable to supply sufficient steam, and Watt proceeded to investigate the matter, to find that a very large proportion of the steam consumed was lost by its condensation against the cold sides of the cylinder. Step by step, in a truly scientific manner, Watt mastered the various problems connected with the use of steam and, in 1765, set about the employment of a separate vessel for the condensation of the steam.

This solution of the problem satisfied every demand; the cylinder might be kept as hot as was desired and the condenser as cold as was necessary with no waste of steam, and a satisfactory vacuum. The immense economy which would result from such an arrangement was self-evident.

In order to preserve the cylinder at a maximum temperature, Watt determined to exclude the external air from it, and to surround it with steam in a closed case. When the vacuum was created under the piston, the steam, acting upon

the top of it, drove it to the bottom of the cylinder, the piston rod working through a stuffing-box in the steam case.

Watt was a poor man, so he entered into partnership with Dr. Roebuck, one of the founders of the iron works which had recently been established at Carron, near Falkirk, for the manufacture of iron with mineral coal. The terms of the partnership were that Roebuck was to pay a debt of £1000 owed by Watt and all the expense of a patent and further experiments, in consideration of which two-thirds of the property in the invention was assigned to him. On January 5, 1769, the memorable patent for "a new method of lessening the consumption of steam and fuel in fire engines" was obtained. Subsequently in May, 1775, an extension of the monopoly for 25 years was obtained. Dr. Roebuck became insolvent and none of his creditors regarded Watt's engine as worth a farthing. Among his debts was the sum of £630 due to Matthew Boulton of Soho near Birmingham. He took up Roebuck's share in the engine patent by releasing him from this debt and by engaging to pay him a further sum of £1000 out of the first profits derived from the engine, and about a year later Watt took up his residence at Soho. The superiority of Watt's engine over Newcomen's in power and economy of fuel was soon demonstrated and the success of the invention assured.

In 1800, the depth of tin and copper mines was 1020 feet and of coal mines 894 feet; by 1880, the English were working tin and copper at depths of 2118 feet and coal at depths of 2808 feet. A century ago (1781) it was considered a great performance to land a load of 600 weight of coal from a depth of 600 feet in two minutes. A colliery in the anthracite region of Pennsylvania (D. & H.) might be instanced where from a depth of 845 feet a load of 9800 weight of coal is now landed in 25 seconds.

By April, 1776, they had two engines in use and orders for engines began to arrive from Cornwall. So rapid was the adoption of Watt's engine in Cornwall that in the short space of five or six years all the engines in the country had been altered, with but one exception. In the colliery districts

the atmospheric engines were much more slowly superseded —a few were in service as late as 1881.

Watt was fully alive to the boundless field which existed for the application of an engine capable of producing a regular rotary motion. His engine was still only a single-acting machine. He determined to apply the steam below, as well as above, the piston (a vacuum being at the same time produced on the opposite side) thus making the engine work equally in both directions, or in other words, double-acting. This form of engine he patented on March 12, 1782. This was the crowning improvement of the steam engine; from having been almost exclusively confined to raising water it now entered upon a career of world-wide utility. Watt patented his sun and planet wheels October 25, 1781, his parallel motion April 28, 1784, and later his throttle-valve and governor-crank, piston packing and indicator. It may help us to appreciate how recently this mighty change took place if we reflect that one of Watt's early engines (of modernized design, however) is said by the "London Engineer" of July 8, 1921, to be still at work at Messrs. Cobbs' Brewery, at Margate.

The invention of the double-acting engine by Watt, in 1782, and the facility with which the machine could now be applied to produce continuous rotary motion, was a great stride toward the solution of the problems of steam locomotion and steam navigation. Watt himself saw the possibilities and covered them in his patent of April 28, 1784, not so much with any intention of taking up the subject, as in order to prevent himself from being anticipated by others.

William Murdock, a highly ingenious Scotch mechanic, the inventor of the oscillating cylinder, and the slide-valve, besides many other ingenious devices, was the Superintendent in Cornwall for Boulton and Watt. In 1784 he made a working model of a high-pressure locomotive engine, which performed well. Watt's remonstrance, "In the meantime I wish William could be brought to do as we do, to mind the business in hand," had the desired effect of bringing Murdock to abandon the steam carriage experiments.

To the last Watt employed steam of a pressure of not more than one or two pounds above the pressure of the atmosphere, but the vacuum was produced under the most favorable conditions, giving a piston pressure of 13 pounds. He had mastered the difficulties of employing steam of a higher pressure but objected to it for the danger which he feared would attend its use.

Watt thoroughly understood all the principles involved in the development of the steam engine and left it very much what it is to-day; the things since added being conspicuously the substitution of more direct modes of connecting the piston with the crank, the high steam pressure, the use of the multiple expansive power of steam, the superheating of the steam to enable its use in a dry state and at a high temperature. In a wonderfully short time the application of steam was developed from a theoretical idea to an almost perfect practice, the most prominent of its properties being: its high expansive force; its condensation by the abstraction of its temperature; its latent or undeveloped heat; and the inverted ratio of its pressure to the space which it occupies.

The great success of Watt's engine led to various attempts to construct engines of different forms, with a view to the evasion of his patents. Among these were the compound, or double-cylinder engine, of Jonathan Hornblower, and the direct-acting or inverted cylinder engine of William Bull, against both of whom he sustained actions for infringement, recovering $200,000 for arrears of patent dues.

The partnership of Boulton and Watt had proved a remarkably happy one. The wealth and influence, the energy and tact of Boulton were invaluable complements to the inventive genius of Watt. On the expiration of the term of 25 years, during which they held the monopoly of the invention, the partnership was dissolved, Boulton and Watt retiring from the business and handing it over to their sons.

178. *Trevithick.*—Richard Trevithick was born April 13, 1771, the son of a mine manager, who bore the reputation of being one of the best informed and most skillful captains in the mines of the Camborne District, Cornwall, and was

himself trained as an engineer. Upon his marriage in 1797, he became a near neighbor of Watt and Murdock, and was undoubtedly familiar with the experiments of the latter. In the year 1800, immediately after the expiration of the Watt's patent, Trevithick was actively engaged in the introduction of his first high pressure engine, or "puffer" as it was called in contradistinction to the noiseless condensing engine, discharging its steam without condensing and directly into the atmosphere.

On Christmas Eve, 1801, Trevithick's first steam carriage was started along the high-road, with about seven or eight passengers, going off "like a bird." It went half a mile up the Beacon Hill, and the next day ran a mile, both journeys being terminated by accidents. On March 24, 1802, Trevithick and Vivian obtained a patent for improvements to steam engines and their application to propelling carriages, etc. In 1803 a second engine ran about a mile. It had a cylinder five and a half inches in diameter, with a stroke of two and a half feet; carrying 30 pounds of steam it worked 50 strokes to a minute. Subsequent trials in London were brought to a close by the frame of the engine getting a twist, the carriage was sold for what it would bring, and Trevithick's attempts to introduce steam carriages on common roads ended. In 1804 he renewed his efforts, this time on a railed road, with an engine working 40 strokes a minute, four and a half feet stroke, eight and a quarter inch diameter of cylinder, weighing with water included, about five tons. It hauled, in five wagons, 10 tons of iron and 20 men, nine miles in four hours and five minutes, the maximum speed being five miles per hour. The weight of the engine broke many of the tram-plates, which were of cast iron. Imperfect as this first locomotive engine was, with its single-cylinder and fly-wheel, its failure was due to the weakness and roughness of the tramroad rather than to defects in the engine itself.

In May, 1805, Trevithick built a locomotive engine for Blackett, of Wylam, but for some cause that gentleman did not take it. Notwithstanding the courage and ingenuity he displayed in connection with the introduction of the high-

pressure steam engine and the locomotive, Trevithick's impatience and impetuosity proved fatal alike to his fame and fortune.

On April 10, 1811, a patent was granted to John Blenkinsop, coal-viewer, covering the use of a rack rail fixed in the center of the railway, or forming part of the rails on one side. He had the firm of Fenton, Murray and Wood, of Leeds, build the engine for him. It began running on August 12, 1812, continued in use many years, the first instance of the regular employment of locomotive engines. The engine, with two eight-inch double-acting cylinders, weighed five tons, and drew 27 wagons, weighing 94 tons, on a dead level, at three and a half miles per hour; when lightly loaded it traveled at ten miles per hour and did the work of 16 horses in 12 hours. It cost £400. Blenkinsop's engines were still used on the Middleton Colliery Railway in 1831.

Within less than a year after the introduction of Blenkinsop's engines, three different methods of effecting steam locomotion were patented by others. On December 30, 1812, a patent was granted to William Chapman, a civil engineer of Durham, for the use of a chain extending along the center of the railway and secured at both ends. The engine was designed to pull itself forward, with its load, by turning a grooved wheel around which the chain was wound so that the wheel could not turn without traveling along the chain. On March 13, 1813, William Hedley, of Wylam, a coal-viewer, was granted a patent, which included several methods of increasing the tractive power of locomotives. On May 22, 1813, a patent was granted to William Brunton of Derby, engineer, for propelling or drawing carriages by means of certain levers or legs.

In this year, 1813, three locomotives, each acting on a different principle, were set to work upon three different colliery railways on the north side of the river Tyne. Messrs. Chapman's chain engine, on Heaton Colliery Railway, was found liable to get out of order, the chain giving rise to great friction, on which account it was soon abandoned; Hedley's smooth-wheeled engine, on Wylam Colliery Railway, at first

went badly, the obvious defect being lack of steam. In a second engine the fire-tube was returned through the boiler; it regularly drew eight loaded coal wagons, at the rate of four or five miles per hour. This year, after many trials and alterations, the "Puffing Billy," provided with two cylinders, was placed in service, and after a long career of usefulness lasting until June 6, 1862, found a resting place in the Kensington Museum. These Hedley engines satisfactorily demonstrated that no further aid was necessary than that supplied by the adhesion of the wheels to the rails. On the Kenton and Coxlodge Colliery Railway one of Blenkinsop's engines was put into service on September 2, drawing 16 chauldron-wagons loaded with coal, a total of 70 tons, at a rate of three and half miles per hour.

Brunton's curious machine, which he termed a "mechanical traveler," was also fitted up this year on the Newbottle Colliery Railway but this mode of haulage being found inconvenient and objectionable, its use was abandoned. Its step was 26 inches long. With a steam pressure of 40 or 45 pounds per square inch, it was propelled at the rate of two and one half miles per hour.

From 1801 to 1825 some 28 railroads were built, ranging from two and one-half miles long to 40 miles long, this last, the Stockton and Darlington, the first to be built for the general service of the public.

For a considerable number of years few improvements of much note were effected in locomotives and, even as late as 1827, its fate still hung in the balance. On many railways the use of the locomotive had been abandoned in favor of rope haulage, and while they were continued in use on the Stockton and Darlington Railway the principal haulage of that line was performed by horses. As yet locomotion by steam had not achieved much success; an efficient form of engine remained to be invented.

At this juncture, Timothy Hackworth, a highly ingenious mechanic, manager of the working department of the Stockton and Darlington Railway, designed an engine in which he introduced important modifications, whereby the power

and compactness of the smooth-wheeled locomotive were much advanced. He was a native of Wylam and took part in the building of the "Puffing Billy." Departing from the then usual plan of having two upright cylinders working on different shafts, Hackworth inverted his cylinders, and placing them on opposite sides of the boiler, applied their connecting-rods to actuate the same axle-tree. At the same time he adopted the return fire-tube which had been used by Trevithick and Hedley, instead of the straight flue employed in Blenkinsop's and Stephenson's engines, and by throwing the escaping steam into the chimney through a narrow orifice, he greatly augmented the force of the steam blast and consequently the rapidity of combustion in the furnace. This engine, which was a six-wheeled coupled engine, the "Royal George," built by Hackworth in 1827, was the first of a new type, and the nearest approach to the modern locomotive of any engine that had yet been built.

179. *Fulton.*—In steam navigation a smooth and level way was supplied by nature. Here Watt's engine, in its most perfect form, could be employed without alteration. James Rumsey, of Virginia, in 1785, and again in 1787-1788, exhibited a boat publicly on the Potomac River and succeeded in propelling it against the current at the rate of four miles per hour. His method of propulsion was by the use of a hydraulic jet, drawing in the water at the bow and forcing it out at the stern. He went to London, induced a wealthy American merchant resident there to finance him, and in February, 1793, placed a vessel on the Thames, attaining a speed of four knots an hour. Unfortunately, he died suddenly in the midst of his experiments.

Almost, if not quite, as early in the field was John Fitch, of Connecticut, who, on September 27, 1785, laid before the American Philosophical Society at Philadelphia, a description, drawing and model of a machine for working a boat against a stream by means of an endless chain of float boards. A vessel built by him was tried successfully on the Delaware River on July 27, 1786. The following year he put a boat on the Delaware River, attaining a speed of six miles per

hour and running between Philadelphia and Burlington. By June, 1790, improvements had been made, which gave the boat a speed of eight miles per hour. In this service the boat must have run between two and three thousand miles, but apparently the company was losing money all the time, since after the vessel was laid up in the autumn, it was not again used. The advances made by Fitch were very great, but he was unable to build a boat large enough or an engine light enough for the work.

Robert Fulton, artist and engineer, an American by birth, had spent some time in Europe, where he was a student of Benjamin West. He became much interested in the design of a submarine, and believing that he had found an excellent mode of taking a purchase on the water, he essayed to apply the Watt engine to the movement. Fulton, in his relation with Livingston, paralleled the fortunate association of Watt with Boulton. Chancellor Robert R. Livingston had become deeply interested in the subject of steamboats, conducting some experiments and procuring an act, in March, 1798, vesting in him the "exclusive right and privilege of inventing all kinds of boats which may be propelled by the force of steam or fire on all the waters within the territory or jurisdiction of the State of New York for a term of twenty years from the passing of the act, upon condition that he should within a twelve-month build such a boat the mean of whose progress should not be less than four miles per hour." (This act was subsequently extended in 1803 and 1807.) In November, 1801, Livingston arrived in Paris as the Minister Plenipotentiary from the United States to France, and shortly afterwards was brought in contact with Fulton. He informed the latter of what had been attempted in America and of his resolution to resume the pursuit on his return, and between them it was agreed to embark on the enterprise.

Some steamboat experiments were made by Fulton on the Seine in 1803, and on the 6th of August of that year, he ordered an engine from Soho, intended for a larger vessel to be built in America. The diameter of the cylinder was

24 inches, with a stroke of four feet. The principal parts of the engine were made and forwarded in 1805. The vessel, the paddle-machinery, and the subordinate parts of the engine, were designed and executed by Fulton himself. The vessel, which was named the "Claremont," was launched in the spring of 1807. It was 133 feet long, 18 feet wide, and nine feet deep. Shortly after being fitted with its machinery (on August 11, 1807) it made a trip from New York to Albany, running the distance of 150 miles in 32 hours, and returning in 30 hours. In September, 1807, it was advertised as a regular passenger boat between New York and Albany.

There is very little new under the sun in the sense of complete and unanticipated inventions. What Fulton did, and the credit should be accorded, was to make steam navigation practicable and to give it a direction which has ever since been followed. To mention as the off-spring of his genius the first workable submarine torpedo boat, the first commercially practicable steam vessel and the first steam propelled warship, is to place him among the giants of the engineering profession.

180. *Stephenson.*—Christopher Blackett's property, the Wylam Colliery, was one of the oldest in the north of England. It was laid down between the colliery at Wylam and the village of Leamington, four miles down the Tyne Valley, where the coal was loaded into barges and floated down to New Castle to be transferred into boats for London. Here Robert Stephenson was employed as a fireman in the pumping station, and here, in sight of the railroad, in a house on the north bank of the River Tyne, about half a mile east of the village of Wylam, to him and his wife Mabel, on June 9, 1771, George Stephenson was born, the second son of a family of six. The boy went to work as a "picker" to clean the coal of stones, bots and dross. By his industry and ability he improved his position step by step. At 15 he was working a twelve-hour shift as a fireman and at 17 was an engineman of the stationary engine. It was not until after this that he went to night school and learned to read. At 21 he was in charge of an engine

at Willington Ballast Hill Colliery, and there married on November 28, 1802. Here was born his only son, Robert, on October 16, 1803. In 1806 Stephenson went to Montrose to run one of Boulton and Watt's stationary engines. By 1813 he was engine-wright, or, as we now say, mechanical engineer, at Killington High Pit and other collieries belonging to Lord Ravensworth and partners, a company known by the name of the "Grand Allies." He greatly improved the mine machinery, and, independently of Sir Humphry Davy, invented a safety lamp to protect the miners against the dangers of fire-damp (carbureted hydrogen gas). He had studied diligently the principles of mechanics and the laws by which his engine worked and had learned mathematics from a neighbor at night. Here, at Killington, Stephenson built his first locomotive, "My Lord," or, as it was locally called, the "Blucher," which was put in service on July 27, 1814. Following the design of Blenkinsop's engine, he employed a cylindrical boiler of wrought iron with an internal wrought iron fire-tube passing through it; two vertical cylinders of eight inches diameter and two feet stroke let into the boiler, with crossheads and connecting-rods to work the propelling gear, but using the smooth wheels. It drew, exclusive of its own weight, eight loaded wagons, weighing altogether 30 tons at the rate of four miles an hour and thereafter worked regularly.

In 1823 Stephenson was appointed Chief Engineer of the Stockton and Darlington Railway, long called the "Quaker Line" since all the original shareholders were members of the "Society of Friends," making the location surveys, superintending the construction, designing all the details of track, structures and equipment and opening the road to traffic on September 27, 1825, the first railway built to serve the general public as a common carrier.

In his testimony before the Parliamentary Committee urging a charter for the Liverpool and Manchester Railway, Stephenson stated that he had entire charge of the steam engines at Killington in 1813, and had superintended the railways connected with the numerous collieries of the

"Grand Allies" from that time downwards. He had laid down, as superintendent, the railways at Burraden, Mount Moor, Springwall, Bedlington, Helton and Darlington, besides improving those at Killington, South Moor, and Derwent Crook. He had constructed 55 steam engines, of which 16 were locomotives. Some of these had been sent to France. Some had been in service over 11 years. When the act was finally passed bringing into existence the Liverpool and Manchester Railway, Henry Booth, the leading spirit of the enterprise, was elected secretary and treasurer and the chief executive officer, and George Stephenson, chief engineer. Although the road was only 30 miles long, the construction was heavy and most formidable. Stephenson planned all the details of the line, designing the bridges, machinery, engines, turntables, switches and crossings and was responsible for every part of their construction. Among other great works was a tunnel a mile and a half long from the station at Liverpool to Edge Hill, worked by hoisting cable, a deep cut at Olive Mount two miles long, in some places 100 feet deep, through red sandstone; the Sankey Viaduct, a brick structure of nine arches, 50 feet span each, the Rainhill "Skew bridge" believed to be the earliest example of an oblique arch constructed in masonry, a most remarkable work and still standing, more than 60 other bridges, and finally the crossing of Chat Moss, a peat bog or swamp some four miles wide, which nearly involved the enterprise in disaster. In the softest places rude gates or hurdles some eight or nine feet long by four feet wide, interwoven with heather, were laid in double thickness, their ends overlapping each other, and upon this floating bed was spread a thin layer of gravel, on which the sleepers, chairs and rails were laid in the usual manner. In forming the embankment the pressure of the bog turf caused a copious stream of bog water to flow from it and when completed the bank looked like a long ridge of tightly pressed tobacco leaf. The compression of the turf was such that 670,000 cubic yards of raw moss formed only 277,000 cubic yards of embankment at the completion of the work.

Double sets of laborers were employed, the night shift working by torch and fire light.

The directors had prepared a very careful estimate of the traffic that the line might expect to secure, and on January 12, 1829, adopted a minute in which they fixed it at 800 passengers, 1900 tons freight, 3750 tons gross weight, Liverpool towards Manchester, and 800 passengers, 2100 tons, 3950 tons gross weight, Manchester towards Liverpool, and these gross weights included the passengers, the freight, the carriages, the wagons and the empties.

It having been decided, after much consideration, to work the railway with locomotives, a competition was arranged for, conditions laid down, and a purse of £500 offered. Booth says, "multitudinous were the schemes proposed to the Directors for facilitating locomotion. Communications were received from all classes each recommending a new power, or an improved carriage; from the professors of philosophy down to the humblest mechanic, all were zealous in their offers of assistance, England, America and Continental Europe were alike tributary. Every element, and almost every substance, were brought into requisition and made subservient to the great work. The friction of carriages was to be reduced so low that a silk thread would draw them, and the power to be applied was to be so vast as to rend a cable asunder. Hydrogen gas and high-pressure steam, columns of water and columns of mercury, a hundred atmospheres, and a perfect vacuum; machines working in a circle without fire or steam generating power at one end of the process and giving it out at the other; carriages that conveyed every one its own railway; wheels within wheels to multiply speed without diminishing power, with every complication of balancing and contra-vailing forces to the *ne plus ultra* of perpetual motion."

The day set for the trials was October 6, 1829, at Rainhill, a suburb of Liverpool. One and one-half miles were measured off, a stake set at either end of the course and one in the middle, and at all three timekeepers were posted. A grandstand had been erected and there was a large con-

course of people. One-eighth mile was allowed at each end for getting up and slackening speed. The distance was to be traveled backwards and forwards ten times, making a total run of thirty miles and for each trip a flying start was to be made. A further condition of the trial was the time in which steam was raised from cold water. Out of a considerable number of engines constructed in different parts of the country in anticipation of this contest, many could not be satisfactorily completed by the day of the trial. Five were presented; one, the "Cycloped," weighing three tons, worked by a horse in a frame, was not admitted to competition as not coming under the specifications. At the preliminary trials held on October 6, the "Rocket" performed the journey drawing a single carriage with 30 passengers. The "Perseverance" could not attain the specified speed and was withdrawn. The "Novelty" was tried on October 10, and on the third round the joints of the boiler gave way and it was withdrawn. It was tried again the next day and again broke down. This engine was built by Braithwaite and Ericson. Ericson afterwards came to this country and during the Civil War built the armored turret "Monitor." The "Sanspareil" was overweight but was allowed to compete, was tried on October 13, and on the ninth round broke down owing to the pump going wrong and frightening the driver, and was withdrawn. The "Sanspareil" afterwards ran on the Bolton and Leigh line until 1844; was then sold to a colliery near Chorley and did duty 19 years as a winding and pumping engine and is now in the South Kensington Museum.

The "Rocket," tried on October 8, was designed by George Stephenson, the original drawings being made by T. L. Gooch. In 1823 George Stephenson had formed a partnership with his only son, Robert Stephenson, Edward Pease, Thomas Richardson and Michael Longridge under the firm name and style of "Robert Stephenson and Company," erecting a plant at New Castle, and here under the personal direction of Robert Stephenson the "Rocket" was built. Steam was raised from cold water in a little

less than an hour and it performed the trial journey twice: the first time in 2 hours, 4 minutes and 8 seconds; the second time in 2 hours, 6 minutes and 49 seconds. Its greatest speed was 29 miles per hour; its slowest 11.5; the average of the first trip 13.4 and of the second 14.2 miles per hour. It pulled 13 long tons weight in two wagons, the live load of stone weighed 9 tons, 1000 weight, three-quarters, 25 pounds (long ton measure), the total moving weight being 17 tons. The engine pulled the cars in one direction and pushed them in the other.

The award was made to the "Rocket" on October 14. This locomotive which inaugurated the era of fast transportation and made possible an industry that has revolutionized society and commerce, remained in service on the Liverpool and Manchester Railway until 1837, when it was sold to the Midgeholme Railway, near Carlisle, where it was once driven four miles in four and a half minutes, or at the rate of 53.3 miles per hour. It is now in the Patent Museum at South Kensington, London, England.

The "Rocket" was a four-wheeled engine not coupled, and weighed a little less than four and a half long tons. The tank carried 700 gallons of water and 800 weight of coal. The firebox was three feet high and two feet wide, the arrear over the grate bars being six square feet, with water legs, the sheets three inches apart, the area of surface exposed to the *radiant heat* of the fire, or that surrounding the firebox, was 20 square feet, the cylindrical boiler was three feet in diameter and six feet long, and had 25 copper tubes one-eighth inch thick and in four rows, from the top row down, numbering four, six, seven and eight, the surface exposed to the heated air or flame from the firebox passing through the tubes or what was then called the *communicated heat* was 117.8 square feet, the two cylinders 8″ × 16½″ were inclined and on an angle of 45 degrees, and coupled to a single pair of drivers, the leading wheels; the drivers were 56 inches in diameter, the two safety valves (one placed where it could not be reached by the engine driver) were set at 50 pounds pressure.

It is generally stated that the "Rocket" owed its supremacy to the forced draft, but it will be seen that the "Sanspareil" also used this method of exciting the fire, it being the invention of its builder Hackworth. The great improvement, and that which made possible the advances of subsequent years, was the increase of evaporating power by the employment of numerous tubes of thin metal and small diameter. This idea was not original with Stephenson but was suggested to him by Henry Booth. Thus the "Rocket," weighing only four and a half tons, had an evaporating surface three and a half times greater than the old engines weighing seven tons and upwards, while its fuel consumption was but 40 per cent of theirs. The value of this improvement was at once recognized. By means of the multitubular boiler and the improved blast-pipe arrangement, steam could now be generated with great rapidity and economy in the locomotive, enabling a higher rate of speed and power to be obtained than had previously been thought of. An important factor in working the locomotive was the mechanism employed to distribute and control the steam—the valve gear. The several forms of the earliest days were superseded by the "hook-motion" until that, in its turn, yielded to the "shifting-link" of Stephenson. The success which attended the use of steam locomotion on the Liverpool and Manchester Railway inaugurated the modern railway system. Immediately after these experiments, engines were made of greater weight and consequently of greater power. By May 29, 1832, such had been the improvement of the locomotives that the "Samson," weighing on two pairs of drivers connected, 10.09 long tons, with cylinders $14'' \times 16''$, driving-wheels 54 inches diameter, steam pressure 50 pounds, tender weighing 7 long tons, drew a train of 50 loaded wagons, net weight 150 long tons, gross weight, including wagons, engine and tender, 240.37 long tons, at a speed between terminals of 12 miles per hour.

It will be of interest, too, to see the use made of the engines in those days. On the Liverpool and Manchester Railway, where the first commercial train handled was loaded

with American cotton, for the half year ending December 31, 1833, the best six engines made the following mileage:

MILEAGE BEST SIX ENGINES FOR SIX MONTHS

Engine	Six months	At a rate for the year of
Jupiter	16,572	33,144
Saturn	18,678	37,356
Sun	14,552	29,104
Etna	17,763	35,526
Ajax	11,678	23,356
Firefly	15,608	31,216
Average	15,975	31,951

Lieutenant Peter Lecount, in his book *A Practical Treatise on Railways,* published in Edinburgh in 1839, gives the following interesting statement of the cost of freight transportation by the various means then in vogue:

The comparative cost of the different modes of transit is, under all circumstances, strongly in favour of railways. For instance, in wagons travelling 2½ miles an hour, the cost of each ton, per mile, for goods, is about 7¾d., of which nearly 3d. is the cost of horsing. In vans traveling at 4 miles an hour with lighter goods, the expense is nearly 1s. per ton, per mile, the horsing costing rather above 4d. of this sum. The expenses of four-horse stage coaches, vary from £4 to £5 per lunar month, per double mile, according as their rate of traveling varies from 8 to 10 miles an hour; their hire and repairs cost 2½d. per double mile; the duty is 3d. per double mile; and the horsing is 2s. The coachman and guard are seldom paid except by the passengers, say 10s. 6d. per week for them at the outside; and for tolls and incidental charges 6d. per mile; being a large allowance. The tolls on the Holyhead road, one of the best in England, are not quite 4d. per mile, for a four-horse coach. This gives 1s. 9d. expenses per single mile, whilst the returns will be 2s. 6d. per mile. From this calculation we have excluded the charge for parcels, etc., leaving it to go, with the allowance for incidentals, to the support of the office establishments. The coaches which ran between Birmingham and London, prior to the opening of the railway, charged £2, 10s. inside and £1, 10s. outside, the distance being 108 miles and after the opening £1, 10s. inside and 17s. outside. Our computation of coach profits we know is under the mark. The cost of this mode of travelling is about 3d. per passenger per mile,

or 3s. per ton, taking 12 passengers and their luggage to a ton. In canal carriage, the cost varies from 3d. to 5d. per ton per mile, in the fly boats going at the rate of 4 miles an hour; and by slow boats, from 1¼d. to 2d. per ton per mile, at the rate of 2½ miles an hour. The passenger boats, going 10 miles an hour, charge from 1d. to 1¼d. per passenger, per mile, or from 1s. to 1s. 3d. per ton of passengers, per mile.

The cost of carriage, by railways worked with horses, is from 1½d. to 2d. per ton, per mile, for heavy, and 3d. to 3½d. for light goods, and from 1d. to 1½d. per passenger, per mile, or from 1s. to 1s. 6d. per ton of passengers, per mile. Those worked by locomotives charge about the same for goods, and rather more for passengers, or from 1½d. to 2½d. per mile on an average. These latter charges however are too high. The resistance by the several modes of transit, is, for railways, 8 lbs. per ton; canals, 2¾ lbs. per ton, at 2½ miles velocity, 7 lbs. at 4 miles, 40 lbs. at 9 miles, and 60 lbs. at 11 miles, which is the greatest hitherto attained. Turnpike roads' waggons, 76 lbs.; vans, 71 lbs. at the before mentioned velocities; and coaches, 80 to 88 lbs. at from 8 to 10 miles an hour.

In whatever light we view the question, no other mode of transit can be put in competition with railroads, except the very slow carriage of heavy goods on canals. But this is not fair comparison, as speed must be taken into account as well as price; and we have no hesitation in saying that upon well managed and economically conducted railroads, goods of every kind can be carried, with proper precautions, quite as cheap as by any canal, and with three times the speed at least. A great deal remains to be done in this department of locomotive transit, and the question cannot be decided on any railway with certainty, till it has been some time in operation, and the mode of working and maintaining it, and of economizing the locomotive power expenses, are reduced to a well regulated system.

During the construction of the Delaware and Hudson Canal Company's railroad, John B. Jervis was chief engineer and Horatio Allen resident engineer, both later to hold very distinguished positions in railroad development. In 1827 Allen was sent to Europe in search of professional information on railroad matter. He was commissioned to take charge of the contract for the iron and to purchase three locomotives for the Delaware and Hudson Company, the first ever ordered and brought to this country. The order for the engines was placed with Foster, Rostrick and Company of Stourbridge, about 15 miles west of Birming-

ham. The first of the locomotives, the "Stourbridge Lion," was shipped from Liverpool on the sailing vessel "John Jay" on April 8, 1829, arriving in New York about the middle of May. It was landed at the wharf of the West Point Foundery Company at the foot of Beach Street, now Pier 26, Hudson River, was blocked up in the yard and steam put on. About the first of July, it was sent up the Hudson River to Rondout, transferred to a canal boat, arriving at Honesdale—the end of track—early in August. The locomotive was set up by Horatio Allen and alone he stood upon its platform on the first experimental trip, August 8, 1829. His hand opened the throttle-valve upon the engine that turned the first driving wheel in America, running up the track two or three miles and back, and repeating the performance several times, so that the "Stourbridge Lion" was in operation in America two months before the "Rocket" won in competition at Rainhill. The engine developed nine horse-power at moderate speed, the boiler was 16.5 feet long, steam pressure 40 to 50 pounds, and there were two cylinders each of 3 feet stroke. It was calculated to propel 60 to 80 tons at five miles per hour.

The railroad was built by bringing the surface of the roadbed to as perfect a level as possible, or incline as the case might be. Square blocks of wood, or sleepers about six feet long, were laid two or three feet apart across the tracks; upon these two long strips of wood six or seven inches wide and about five inches deep, were fastened by pins, parallel to each other and about four feet apart. Upon these wooden rails was spiked a projecting round molding of wood and the wheels were hollowed out like a pulley to fit upon the round surface of the molding. Jervis says that the locomotive worked very well and no doubt would have done good service, had the trestle work (of which there was a large portion on the road) been sufficient to sustain the weight of the engine in working. It was the intention to have engines of one and a quarter tons on a wheel at the heaviest, but the builders of the engine at that time had little experience, and when the machine

was constructed it was found to have nearly two tons on a wheel, and this the road was not designed for. The "Stourbridge Lion" is now at the Smithsonian Institute at Washington, D. C.

The first American locomotive built for actual service was called the "Best Friend of Charleston." It was built by the West Point Foundery Company from designs by Peter Cooper and put in service on the Charleston and Hamburg Railroad, South Carolina, in January, 1831. On June 17 following, the boiler exploded, because of the negro fireman sitting on the safety valve. In 1831 Horatio Allen designed for this road the first eight-wheel engine, and in August, 1832, Jervis put in service on the Mohawk and Hudson Railroad the first locomotive, the "Brother Jonathan," with a bogie truck, the object being to have a leading truck under the front part of the locomotive to assist in sustaining the weight of the boiler and in giving direction to the locomotive in running around curves, a plan later universally adopted as indispensably necessary in engines of eight or more wheels, and especially upon the sharp curves of American railroads. Few devices have had more far reaching results on the social life of our people than the bogie truck in our locomotives, passenger and freight cars.

The city of Baltimore is at the head of navigation on the Chesapeake Bay. When its trade with the Ohio and Mississippi Valleys was threatened by the construction of the Eric Canal in New York and the Public Works of Pennsylvania, it sought to protect it by the construction of a railroad, affording what was then a new mode of conveyance.

The books for subscription to the stock of the Baltimore & Ohio Railroad were opened on March 20, 1820, and closed on March 31, when 22,000 persons had subscribed to $4,178,000 of the capital stock of the company. This was at a time when the population was about 70,000 and the aggregate of the real and personal wealth only $25,000,000. Few projects have been launched since which overshadow

this beginning of the Baltimore & Ohio Railroad from the standpoint of its relative magnitude, or of the courage, persistence and dogged determination of the community which undertook it.

The cornerstone of the enterprise was laid amid public rejoicing by the venerable Charles Carroll of Carrollton, a director of the railroad, then 91 years old, the only surviving signer of the Declaration of Independence. The last rail was laid on Christmas Eve, 1852. On January 1, 1853, the road was opened to its projected terminal, Wheeling, on the Ohio River. A gala function, at which there were appropriate and public ceremonies, was held on the twelfth of that month, and at the banquet held to celebrate the occasion, John H. B. Latrobe, the attorney of the company, said:

> In 1836, the Baltimore and Ohio Wagon Company, with a capital of $200,000, one-fourth paid in, transported goods between Wheeling and Baltimore. One wagon departed and arrived daily, with a load weighing 2½ tons, and occupied eight days upon the road. In 1853, the Baltimore & Ohio Railroad is opened with a capital of $12,000,000, all paid in; to complete the work would increase the capital to $20,000,000. The journey would be reduced to a day and a half, the engine will weigh 12½ tons and will haul at 12 miles per hour 300 tons gross weight.

Well might Latrobe say:

> We speak of the array of a conqueror; where is there a conqueror like steam? Its panoply, too, is of iron; man has made it not less than mortal, as it performs the work of 100,000 of men's hands, and, as it is impatient of delay, it rushes through the bosom of the hills, its white and feathery plume is the ensign of daring, a courage, that treads its way through the forest, or climbs the side of a mountain, and a power which, while it may find its comparison in the crest of Henry IV at Ivry, is the precursor of the triumphs, not of war but of peace, as they build up the fame, not of heroes, but of the people. That the fruition of these hopes will disappoint no reasonable expectations, but surpass them all, who of us can doubt?

The practical value of the historical sense is the intelligent anticipation which it fosters. History should be an

illumination of the mind, not something worse even than a burden on the memory. It should afford the best protection against the blind optimism which discounts every disagreeable fact as having no more than a casual and transitory significance and accepts every agreeable fact as the expression of an irresistible force for good. It should teach us, too, the significance for the race of its gifted individuals. Bagehot, the economist and historian, writing over 60 years ago, declared that there were not more than 10,000 well educated persons in Great Britain; that is, persons who could think accurately and think for themselves. Would it be an exaggeration to say that to-day there are 50,000? It is to these that we are indebted for the steadiness and consecutiveness of progress but it is to the genius of a few hundred individuals, among the thousands of millions who have lived, that we owe all the inspirations of philosophy, music, art and literature, all the benefactions of science, discovery and invention.

181. The Engine.—The whole matter of locomotive condition, handling and mileage, is a prime transportation device. Too light locomotive mileage is readily corrected by the withdrawal of power, while the knowledge of a reserve stock in "white lead" and in the best of condition to be drawn upon as emergency or traffic increase demands is a solid comfort and reassurance. The association with the mechanical people to avoid delaying movement because of repairs, the lack of or character of the repairs and the satisfactory movement both on the road and in the yard, which with the number of locomotives to be kept in service are in the personal control of the transportation officer, gives interest and variety to his work and vigorously tests his character and capacity.

The life of the locomotive in service has three phases: (1) it may be in the hands of the transportation forces in yard or road service, and this is its only useful period; (2) it may stand idle in the roundhouse O.K.'d for service by the maintenance of equipment forces but awaiting use; a locomotive lying idle from 12 to 24 hours is a sheer trans-

portation loss, not an uncommon experience; or (3) it may be in the hands of the maintenance of equipment forces being prepared for housing or service, or undergoing necessary repairs. Economy requires that every effort should be made to avoid unnecessary repairs and to expedite those that are necessary while prosecuting them with the minimum possible interference with service.

182. Movement at Terminals.—The engine housing or preparation involves a group of Maintenance of Equipment men who work about what are called the engine dispatching facilities. Let us follow the locomotive in its journey from the time it arrives from the road until it is out of the enginehouse and on the dispatch track waiting for its next trip. It is the practice on The Delaware and Hudson to have the locomotive left on the ash pit by the engineman, with its boiler full of water, cylinder cocks open and brakes applied. The engineman makes out a work report of the repairs necessary and notes any peculiarities in the action of the locomotive during the trip. After the fire is cleaned, which takes from 45 minutes to one hour and 15 minutes, the locomotive is moved to the coal dock and coal taken, requiring five to ten minutes, dependent on whether coal supply is mixed (consisting of 30 per cent bituminous and 70 per cent anthracite) or sandwiched in layers. The locomotive is then advanced to the penstock and tank filled with water and sand taken, which takes approximately five minutes. At major terminals tools are then removed and taken to the tool house and the locomotive is further advanced to the wash track, where it is washed by the D. & M. system which consists of a mixture of hot water and oil sprayed on by air pressure and requires 15 minutes. As paint appears worn, fresh coats are applied so that in the course of six months a locomotive is practically completely repainted; in this way the engine always presents a clean, neat and attractive appearance. On roads using bituminous coal it is the usual practice to leave the locomotive with a full tank of coal and to fill the sandbox before placing on ash pit. If a washout is due, the fires are

dumped. Where inspection pits are installed they are placed in advance of the ash pits. Where such advance inspection is not made, the hostler then puts the locomotive in the roundhouse where a thorough inspection of all parts is made, and repairs done as reported necessary by the engineman or found necessary by the inspector. When ready for service the fact is reported to the Yard Master's office. When the locomotive is ordered for service it is taken by the hostler, the tank filled with water, and the fire tools, engineman's tool box, and a supply of engine and valve oil placed on the engine. The engine crew reporting finds the locomotive ready except inspection of flue sheets, oiling around and trimming of fires.

The repairs divide into two classes, "running repairs," made in the roundhouse and undertaken practically every time the locomotive is brought in, and "general overhauling," undertaken at intervals of from 12 to 15 months, when the locomotive is withdrawn from service and placed in the back shop. The annual cost of these two classes of repairs, when averaged over the life of the engine, is about equal. The wear on the several parts of the locomotive is not uniform and there are times when this general overhauling can be postponed for from three to six months by a withdrawal for minor repairs that may be made in four or five days. With a properly organized force of sufficient strength and with a proper equipment of facilities and tools, the average time daily required at home terminals for the running repairs is three hours, and one hour at turn-around points.

The work done in the roundhouse, as may be indicated by its cost, is of very great importance. Here wheels are dropped to replace broken or worn bearings, cylinder and rod packing renewed, crossheads lined, rods bushed, etc. The boiler is each twelve months subjected to hydrostatic test at water pressure 25 per cent above working steam pressure and a thorough examination made of the interior as far as possible. At fixed intervals, varying from each trip to 30 days, the locomotive is washed out, all boiler

plugs removed, tubes washed and scales and deposits removed. A roster is kept both of locomotives so handled, and of the dates of those due for handling within 30 days. The hydrostatic test should be made in from 4 to 24 hours, dependent on whether or not the full removal of jacket and lagging over the casing sheet is made, and the number of broken bolts discovered. The washout period, with the use of warm water, should not exceed three hours.

If the roundhouse foreman reports to the yard office 3½ hours after he receives it at home terminal and 1½ hours at turn-around terminal, as he should be able to do, that the locomotive is "O.K." for service, any additional delay is placed unmistakably upon the transportation forces.

If we follow the locomotive through the back-shop in its general overhauling, we find various repairs made every 15 months while others are spread over a period as long as 30 years, as shown on Figure 29. As a consequence the expense involved varies considerably. The locomotive is composed of about 15,000 pieces, each replaceable, and when properly maintained is at all times as efficient as when turned out by the builder. The old form of accounts, "Repairs" and "Replacements," reflected the true state of facts; whereas, the present form, "Repairs," "Depreciation" and "Retirements," obscures the facts, at least where these machines are in sufficient number to make the work rhythmical or recurring in regular ratio without disturbing the gross amount of one year compared with another. Under good practice the time the locomotive is held in the erecting shop for general classified repairs will ordinarily be 21 working days, and, with firebox or boiler renewal, 28 working days.

When locomotives are stored, the fires are dumped, joints broken, pipes drained, stack covered, all parts cleaned and greased (white leaded), all cocks left open, the cab boarded up and the locomotive placarded "Stored."

Yardmasters should give the terminal locomotive movement more direct supervision; the road foreman of engines strict attention to the duty of locomotive crews; and the

trainmaster, or his assistant, personal supervision of road crews. Direct communication should be maintained between the offices of trainmaster, yardmaster and roundhouse foreman, concerning the terminal movement of engines. A telegraph operator is kept on duty at the office of the roundhouse foreman and there is direct railroad telephone connection between his office, the yard office, erecting shop, car repair shop, the passenger station and the freight depot.

The handling of power should be watched:

1. To see that no interruptions take place in the movement between terminals, including yard movements. The time of the train on the road is affected by the character of the train dispatchers, the number of telegraph offices and the distance between them, and the supply and arrangement of the other train movement facilities. The largest road mileage of locomotives is obtainable when the most business is offered.
2. To expedite the movement of the incoming train to the ash pit and the roundhouse at terminals where locomotives using bituminous coal have to be completely cared for, the time of detention in the roundhouse should not exceed 2½ hours, and the time between ashpit and roundhouse 45 minutes where the work includes coaling, and 35 minutes where it does not, a total of 3 hours and 15 minutes. At intermediate points and small terminals where no facilities for complete repairs are provided, the time in roundhouse should not exceed 1½ hours, and the time between ashpit and roundhouse, 45 minutes, a total of 2 hours and 15 minutes.

   Where anthracite is used the actual time from arrival of the locomotive at the ashpit at home terminal until it is ready for the next trip is about 5 hours or from the ashpit to the roundhouse about 1½ hours' inspection and repairs 3 hours and supplies 20 minutes.
3. The movement of locomotives to and from trains in yards is an important factor in the utility and availability of power. If the roundhouse is adjacent to the yard, 15 minutes would be a liberal allowance for the movement. If one or two miles distant but connected by a running track, 15 minutes should be sufficient; but if the main tracks have to be used, 30 minutes may be required. Often economical practice may involve changing yard crews at an outlying point to avoid the delay involved in bringing the locomotive to the roundhouse and returning it for service.
4. To reduce the detention in the roundhouse.

5. To expedite the movement between the roundhouse and the outgoing train, the yard master should anticipate by not less than two hours the time trains will be ready, and not wait until they are made up before ordering locomotives. Trains should be made up, brakes tested, and train ready to leave at time set. There should be a minimum of 2 hours call for engine crews. The locomotive should be on hand 30 minutes before the time fixed for departure of train. Cabooses should be put on trains by yard engines, thereby avoiding delay incident to backing train to caboose. The time consumed by locomotives in waiting for trains at terminals is likely to average not less than 3½ hours or 12 per cent of its life. This should permit of substantial reduction.

A study of Figure 63 will show how vital is the effect of the round-house and its accompanying engine dispatching facilities. They may well engage much of the time and attention of the transportation officer. The ability to take care of locomotives promptly is in busy times the ability to prevent blockades.

183. Movement on the Road.—The manner in which engines are crewed exerts a powerful effect upon the economical use of this power.

(*a*) *Assigned Power.*—The one-man-one engine practice has many supporters. It is claimed that the locomotives present a better appearance, are more skillfully handled, use less fuel, that the men take more interest in the machine and in its work, report defects more carefully and frequently, that the locomotives give a greater mileage between shoppings, and that total expenses for repairs are reduced. On the other hand the mileage of the locomotive per annum is restricted, and the capital investment for added engine equipment increased. Few enginemen care to make more than 26 trips per month, and, if one did, pressure would be brought to bear on him to prevent it by those who believe in "making jobs." This limits the mileage for the year to say about 28,000 engine miles, according to the length of the division. Where the earnings run high the Brotherhoods often fix a limit of 20 trips per month.

(*b*) *Swings.*—In "swing runs" two men are regularly assigned, each to one of two locomotives, while a third man runs alternately first one and then the other locomotive, "swinging" from one to the other.

(*c*) *Links.*—The link is such a combination of crews and locomotives in a series of runs as will tend to produce the maximum economical mileage of locomotives.

The "link system" is the quite customary practice in England but is little used in this country. Its distinctive feature is that there should be a greater number of crews working with a lesser number of locomotives, and that any one link shall not comprise the entire number of crews on one division. It is an intermediate practice having many of the advantages of either extreme, and avoiding some of their drawbacks. It increases the engine mileage and by monthly rotating shifts offers an opportunity of equalizing the pay and working conditions of all the men in each link. In passenger service and for "fast freights" the link system is especially convenient and should be more widely used than it has been in this country. As against the regular assignment, increase in engine mileage of as much as 25 per cent is frequently obtained. Its simplest form is in "swing runs." More elaborate arrangements cover, say, nine enginemen to six locomotives and other combinations in great variety and offer a fine field for thought and ingenuity.

(*d*) *Running the Rounds.*—In "running the rounds," or the "first-in-first-out" system, the crew is not assigned to a particular locomotive or group of locomotives, but takes the one assigned when called. The principle of the system is that the next engine crew in order shall take the next engine in order, and thus, by having engine crews in sufficient number to keep the locomotives in constant use, more service can be got from the engines. This practice calls for a high degree of oversight of the locomotives and their movement at terminals, but by having more crews than locomotives secures the greatest mileage obtainable from the locomotives and the system is especially adapted to heavy traffic. It makes possible the "white leading" or laying up of surplus power or its transfer

to other divisions where needed and the distribution of the work assignable equally among the crews. It is likely to yield an increase in locomotive mileage of more than 33 per cent over the regular assignment and the increase may run as high as 50 per cent. Under this practice the roundhouse inspection and repair work requires to be brought to a high state of efficiency and the discipline of the crews in reporting as to the condition of the locomotive and repairs needed must be carefully followed up. The economy will amply justify a considerable increase in the inspection force.

Paine sums up pretty well the views of those who favor "pooling." During the first half century of railroading the locomotive was regarded with some superstition, if not with awe; it was the fashion to marry it to one man for life; no one but the familiar engineer was thought to understand the caprices of the petted machine, no one else could get her to pull a heavy load or a quick train; he only knew the springs of action, and when he was tired the engine stopped. These foolish notions found defenders for a long time after they were seen by sensible men to be mistaken, on the ground that the sentimental regard of the engineman for his own locomotive would cause him to maintain it in a more perfect condition than could be attained in any other way.

To conserve investment capital, we should get every hour's work out of it we can; if the locomotives are out on the road earning money they will not need so much enginehouse room as if housed during the half or the greater part of their existence. Now that locomotives are built more for business and less for show, it is only necessary to place them over the steam pipes, in cold weather, to clean the machinery of ice, so that it can be thoroughly wiped; if thus properly attended to by the hostler, they will not then suffer any damage from exposure. It is better for boilers to be kept constantly warm rather than to be frequently cooled, because when cooled they suffer contraction and conseqent strain. It will also result in saving fuel to keep from growing cold a locomotive which comes off the road hot, unless it is to stand too long. The quantity of coal required to fire up a cold boiler will keep a

hot one warm a long time. The locomotive should be maintained in such good order that any man can run it successfully who can run a locomotive at all.

There is more frequent necessity for the renewal of the smaller parts of the locomotive than there should be; the breaking down of the locomotive while on the road occurs oftener than is creditable to our constructors or our Master Mechanics. When a locomotive is sent out to take a train it ought to run through without hindrance from defects in machinery. Nor can many of these defects longer be overcome by the engineman, owing to the great weight of the parts. There is no doubt that rotation, first-in-first-out, will produce the most wide-awake set of men, the smartest competition among them, the fairest apportionment of labor, and the surest readiness for every emergency. By the adoption of the first-in-first-out method of engine dispatching, the Pennsylvania Railroad increased the annual mileage per locomotive from 19,244 miles in 1870 to 27,644 miles in 1881.

The economy of fuel consumption is so important that it should be secured by all possible means. Many roads have tried successfully the payment of premiums to the engineman and fireman for the savings they effect when compared with a fixed and reasonable standard of performance.

184. Engine Rating.—In considering the use to be made of the road locomotive the first thing to be determined is its rating in hauling capacity. The work to be done by a locomotive in moving a train is in overcoming resistance of various kinds.

1. Speed, the time that a train unit may occupy a given length of track.
2. Acceleration—bringing the train from standing to road speed.
3. Gravity, affecting the combined weight of car and load.
4. Curvature.
5. Resistance of the car considered as a vehicle.
6. Weather conditions.
    (*a*) Low temperature, increasing the radiation from the boiler, cylinders, etc., and reducing the effective steam power.

(b) Snow, increasing flange resistance.
(c) Condition of rail due to falling leaves, rain, frost, sleet, grease, etc., reducing adhesion.
(d) Side and head winds.

The first four items are combined in the engine "rating," the last in modifications and departures from the "rating," authorized by the superintendent or train dispatcher.

(a) *Tractive Power.*—The force used in moving the locomotive is the expansive power of steam. While generated in the boiler and used in the cylinders, it is utilized at the point of contact of the driving wheels with the rails. It is exerted upon the piston and augmented by the length of the stroke and varies with the size of the driving-wheels. This force, usually spoken of as tractive power, was first formulated by Pambour as:

$$T = \frac{d^2Lp}{D}$$

or square the diameter of the piston in inches; multiply this by the length of the stroke in inches, multiply the sum thus obtained by the mean pressure of steam per square inch (usually taken as 85 per cent of the rated boiler pressure) and divide the result by the diameter of the drivers in inches. In using this formula the tractive power given is that developed by both cylinders of a single expansion engine.

(b) *Adhesion.*—But this tractive power cannot be fully realized. The efficiency of its application is dependent upon the adhesion of the wheels to the rails. The area of contact is dependent upon the load and upon the contours of the top of the head of the rail and of the tires of the driving-wheels, whether flat or curved or more or less worn. Rails and wheels represent a vast number of contours each differing more or less from the others. Due to the balancing of the reciprocating parts the dynamic pressure at average speeds will exceed the static pressure by about 10 per cent. As the resistances to be overcome are greatest in starting the train, it is adhesion under static pressure that is of prime importance. Giving consideration to all these variables, it is evident a fair

average of contact area only can be stated, which, for the modern heavy freight locomotive, will probably be not far from one square inch for each 100,000 pounds of weight on the eight driving-wheels; or, for a large modern consolidation locomotive of 250,000 pounds weight on the drivers, say, two and one-half square inches.

The adhesion of the smooth surfaces of the wheels and rails in these very small areas is due to weight alone. The adhesion is diminished by the effect of the torque due to the alternate working of the two cylinders; by the reciprocating motion imparted by the piston movement; by improper handling of reverse gear and throttle by the engineman, and by the condition of the rail. Experience has shown that about one-quarter of the weight on the drivers can be relied upon as resistance to the "tractive force."

It is very desirable to carry on the driving-wheels all the weight possible in order to utilize it as adhesion. For that reason four-wheel leading trucks and trailing wheels should be avoided if possible. Not only do they carry a part of the weight which would serve a useful purpose if carried by the driving wheels but, through their bridging effect, they lift off the drivers a certain amount of weight, both of which facts tend to decrease adhesion. The recently developed "booster," an auxiliary engine working on the trailing wheels and brought into use in starting the train or when the train falls to low speed at summits, tends to remove the serious objection to the trailing wheels. If the "booster" is applied to the locomotive tender, the objection to the trailing wheels will still remain.

If the engine is over-cylindered, that is, if the "tractive power" supplied is greater than can be balanced by the adhesion, the wheels will "slip," turning on the rail without advancing the locomotive. Slipping may also occur even where the tractive force and the adhesive force are in proper relation by calculation through disturbance such as "bad rail." The weight that can be utilized on a wet rail is not more than half as great as on a dry rail. By the use of sand this condition of the rail may be largely overcome.

(*c*) *Factor of Adhesion.*—The resistance of the driving-wheels to slipping, that percentage of the total weight on the driving-wheels that can be relied upon as resistance to the tractive force, is known as the "factor of adhesion." No unanimity of opinion exists among motive-power officers as to the value to be given to this factor. It will be found to vary in its use by them from 3.55 to 4.40. This variation of one of the arithmetical values destroys the validity of comparison of many of the data regarding locomotives. It would seem that the Mechanical Division of the American Railway Association might well adopt a standard practice.

(*d*) *Draw-bar Pull.*—The "draw-bar pull," that is, the force that can be relied upon in practice to move the train, is the "tractive power" of the locomotive diminished by the inability to realize the full "adhesion" and by the force necessary to move the locomotive itself with its tender and overcome the resistance offered by each. Expressed in pounds it may be taken as nine-fortieths of the weight in pounds carried on the drivers when starting the train. The "draw-bar pull" is exerted on a train ordinarily made up of cars of different types and of different weights and capacities.

(*e*) *Adjusted Tonnage.*—The method in vogue for rating the locomotive in the 1880's was based on its ability to haul a certain number of cars, five empties being considered the equivalent of three loads. With the wide variations of weight of lading, this method was found not to secure the desired result.

The hauling of the car requires the overcoming of resistance that may be grouped under two heads, weight and mechanical.

(1) The force of gravity: If the car were lifted vertically, only the force of gravity would work against it. It acts pro rata on the weight or strictly in proportion to the weight. Grade resistance then is a constant, a matter of the application of ratios, 20 pounds per ton on a 1 per cent grade and 10 pounds per ton on a 0.5 per cent grade.

(2) The mechanical resistance: This varies with the weight carried on the axles of the car, journal friction, the

character of the truck and side bearings, rolling friction, the couplings, flange friction, tendency of the truck to slew and hug the rail, etc., etc. Besides these, wind resistance and temperature must be taken into consideration. But these resistances do not increase as rapidly in proportion as the weight of the car increases. It is this difference in the mechanical resistance of cars of different weights that makes it possible to move more tons of heavier than of lighter cars

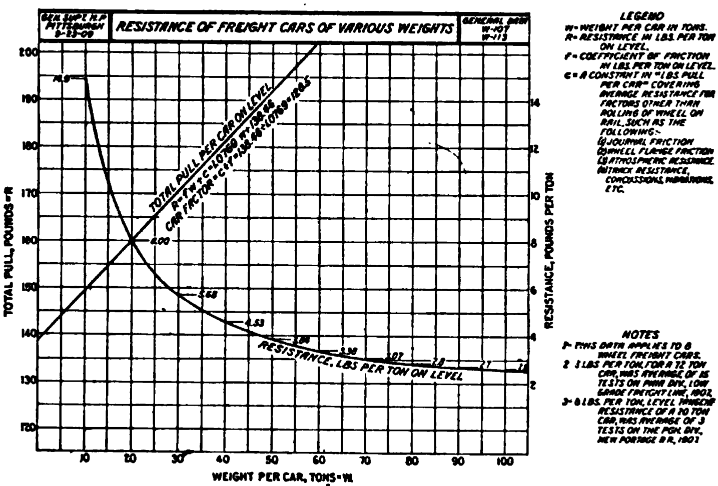
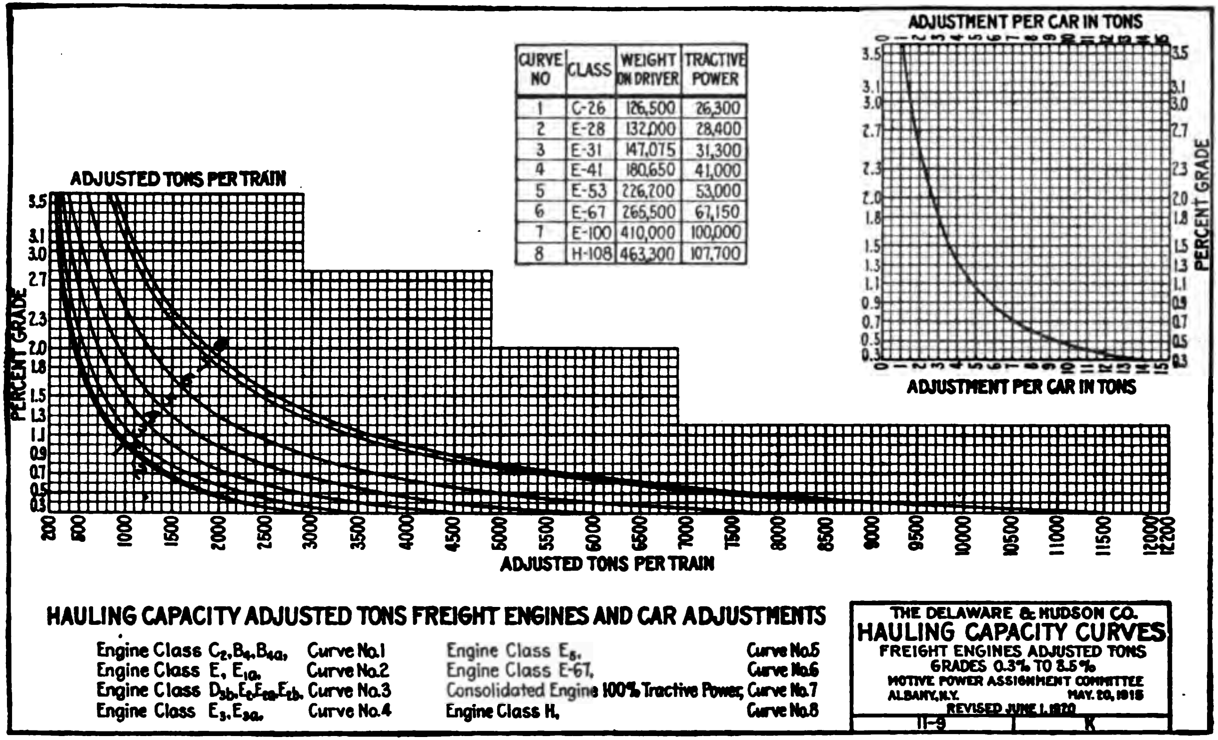


FIG. 60.

with the same draw-bar pull. On a straight and level track the entire weight of the car is on the journals, and, if all the parts are in good working order and there is no wind, the only force to be overcome is the mechanical resistance. The varying degrees in which force must be supplied under those circumstances to move cars of different weights when fully loaded is shown in Figure 60.

Many experiments lead to the fixing of the power necessary to be exerted at the draw-bar to move the train on level track at four pounds per ton. This resistance varies with the total weight of the car and loading. It will be as much as eight pounds to the ton for an empty steel hopper car weighing 20 tons and as little as three pounds to the ton for a loaded



CURVE NO	CLASS	WEIGHT ON DRIVER	TRACTIVE POWER
1	C-26	126,500	26,300
2	E-28	132,000	28,400
3	E-31	147,075	31,300
4	E-41	180,650	41,000
5	E-53	226,200	53,000
6	E-67	265,500	67,150
7	E-100	410,000	100,000
8	H-108	463,300	107,700

Fig. 61.

steel hopper car with a total weight of 72 tons. To those who have misgivings about the future of the railroads it will be well to compare this with the power necessary to be exerted by an automobile truck with solid rubber tires on a level highway with concrete surface which, in the case of a five-ton loaded truck, for example, is about 48 pounds per ton.

In practice it is not necessary to determine the value of each of the several items of mechanical resistance; they may in total be determined for the car as an average vehicle by dynamometer tests or by algebraic comparison of the weight and number of cars in trains of the same weight, all loads and all empties. Further, it is practicable and convenient to state the resistance thus determined as "adjusted" tonnage, an arbitrary amount, the equivalent of an average weight for each car, to be added to the weight of the empty cars together with the weight of their loads in making up the full tonnage that can be moved on a given grade by an engine with a given draw-bar pull.

These car tonnage adjustments as used on the Delaware and Hudson, together with total adjusted tons per train, are shown on Figure 61. The great practical importance of attention to this detail is indicated by the makeup of two trains of 3000 tons for movement over a division of maximum 0.3 per cent grades, where the "adjusted" tonnage allowance per car is 14.5 tons, as follows:

70-ton cars

Lading Iron Ore (10 per cent in excess of marked capacity)	77.0	tons
Tare	24.5	"
Adjusted tonnage	14.5	"
Total	116.0	"

3000 divided by 116 gives 26 cars per train.

The total tonnage handled would, therefore, be:

Lading, 77 × 26	2002	tons
Tare, 24.5 × 26	637	"
Adjusted tonnage, 14.5 × 26	377	"
Total	3016	"

Percentage of paying load.......... 66.3

50-ton box cars

Lading (L. C. L. average)	7.7	tons
Tare	24.0	"
Adjusted tonnage	14.5	"
Total	46.2	"

3000 divided by 46.2 gives 64 cars per train.

The total tonnage handled would, therefore, be:

Lading, 7.7 × 64	492.8	tons
Tare, 24. × 64	1536.0	"
Adjusted tonnage, 14.5 × 64	928.0	"
Total	2956.8	"

Percentage of paying load......... 16.6

Different ratings are provided for varying conditions of temperature, as follows:

(*a*) The maximum or "A" rating for above 30 degrees Fahrenheit.

(*b*) The next or "B" rating for above 20 degrees—up to and including 30 degrees Fahrenheit. (Add 1 pound per ton to resistance of loaded and empty cars for rating above 30 degrees Fahrenheit.)

(*c*) The next or "C" rating for above 10 up to and including 20 degrees Fahrenheit. (Add 2 pounds per ton to resistance of loaded, and 3 pounds per ton to resistance of empty cars for rating above 30 degrees.)

(*d*) The minimum or "D" rating for 10 degrees Fahrenheit or below. (Add 4 pounds per ton to resistance of loaded and 6 pounds per ton to resistance of empty cars for rating above 30 degrees.)

(*e*) With heavy snow or wind, bad rail or locomotives in indifferent condition, special allowance must be made to meet the condition.

(*f*) Care should be exercised, when the temperature is below 30 degrees Fahrenheit and varies during a 24-hour period, that the highest permissible rating is used for runs which occupy the time of day when the most favorable temperature, rail and weather conditions may exist.

(*g*) In making up trains the loaded and heaviest capacity cars should be placed ahead and house car doors should be closed and locked.

Where possible, careful road tests of locomotives in first-class condition and efficiently operated and fired should be

made, using a dependable dynamometer car and crew. Careful observation should be made of heavy pulls on grades made irregular by bad track work; curves uncompensated, with tight gauge or with inaccurate elevation; sidings; approaches to yards; fuel and water stations; non-interlocked railroad crossings, and the like, and corrections made where possible.

The origin of tonnage rating and the genesis of "adjusted tonnage" is as follows:

When the panic of 1893 came on, I was superintendent of the Cleveland and Pittsburgh Division of the Pennsylvania Lines West. The attention of every one was sharply directed to securing economy in the operations and saving every dollar possible and the means of bringing this about were the subject of many consultations with the staff and much effort on the road. Among the other matters discussed was the saving of locomotive fuel, which is always a very large item in transportation expense, and it was decided to take this matter up systematically. For many years the Pennsylvania had been paying a "premium" to enginemen and firemen for the economical use of fuel, dividing the value of the coal saved, based upon an arbitrary allowance of so many pounds per engine mile and so many pounds for each car moved one mile by the engine. I realized that this premium system had suffered from what has been the destruction of so many of the piece work and premium systems, namely, as men began to earn what the clerks in the motive power department thought were unwarranted amounts, they changed the basis of the rating, so that the first thing I did was to secure an agreement with the superintendent of motive power that the basis upon which we fixed should not be disturbed before the end of the experimental period. We divided the year into halves, throwing October into the winter rating because of the bad condition of the rail, due to falling leaves. As there was a large number of men to supervise and many of them expert in their work, we utilized the information in our possession from the premium records and concentrated our attention each month on the ten men who were at the bottom of the list the preceding month. We effected a saving during the year of 18 per

cent in the amount of coal used, which was, it is needless to say, a matter of great satisfaction to everyone and of considerable profit to both the company and the engine crews.

It soon became apparent, however, that the result depended not alone upon the skill with which the engine was handled and fired, but upon the character of cars that were being hauled, which varied greatly in weight and in ease of running. We had one type of car especially, the southern tubular-frame car, that was very hard to pull, and to handle them at the lake ports we had to raise the grade on the "kickbacks." I therefore undertook to determine what seemed to be the resistance of the car beyond the resistance due to weight of car and load, and moved two trains south from Cleveland, one comprised entirely of loaded cars carrying iron ore, which had been carefully weighed at the iron ore docks, and one consisting entirely of empties, the total weight of which was exactly equal to that of the train of loads. The result was somewhat surprising. In going down grades of 40 feet to the mile the crew had to set brakes on the loaded train to steady it down the hill, the engine drifting. The locomotive pulling the train of empties had to make steam to pull the train down the same grades. A contrast of these results worked out by algebraic equation gave a weight measure of seven tons per car as the resistance of the vehicle independent of its own weight and the weight of the lading.

We subsequently worked out, by dynamometer tests, the resistance on a variety of grades throughout the system. Upon severe grades, such as two per cent, where the power exerted by the engine is largely used to overcome gravity, this resistance, expressed in weight, is as low as two tons. On divisions with low grades, such as three-tenths per cent, where the force of gravity is exerted in very low degree, this resistance, expressed in weight, runs as high as 14.5 tons. This led to the rating of the engine by "adjusted tonnage," taking into consideration the number of cars in the train, as well as the weight of the cars and their loads, and the grades to be overcome (see Figure 62).

It has been a matter of surprise to me that in the applica-

Fig 62.—THE DELAWARE & HUDSON COMPANY

PROPOSED ADJUSTED TONNAGE RATINGS,[1] MAIN LINE, MOTIVE POWER ASSIGNMENT COMMITTEE, ALBANY, N. Y.

Northward								Between	Southward							
Pusher Factor	Car Adj.	Class Locomotive					Rating		Rating	Class Locomotive					Car Adj.	Pusher Factor
		E-31	E-41	E-57	E-67	E-100				E-100	E-67	E-57	E-41	E-31		
		1650	2150	3050	3650	5300	A	Wilkes-Barre	A	5300	3650	3050	2150	1650		
1.4	7	..	..	..	..	−10%	B	&	B	−10%	..	..	..	..	7	0.7
						−20%	C	Carbondale	C	−20%						
		2150	2800	3900	4700	7000	A	Carbondale	A	4600	3200	2700	1890	1450		
2.0	9	..	..	..	..	−10%	B	&	B	−10%	..	..	..	..	6	1.1
						−20%	C	Nineveh	C	−20%						
		3500	4550	6400	7700	11,100	A	Nineveh	A	11,100	7700	6400	4550	3500		
0	14	..	..	..	..	−10%	B	&	B	−10%	..	..	..	..	14	0
						−20%	C	Oneonta	C	−20%						
		1450	1890	2700	3200	4600	A	Oneonta	A	4200	3000	2400	1700	1350		
0	6	..	.	..	..	−10%	B	&	B	−10%	..	..	..	..	5	0.8
						−20%	C	Glenville	C	−20%						
		2730	3500	5050	6100	8800	A	Glenville	A	10,000	6900	5700	4000	3100		
0	11	..	..	..	..	−10%	B	&	B	−10%	..	..	..	..		
						−20%	C	Saratoga	C	−20%					13	0
		2290	3000	4150	5000	7300	A	Saratoga	A	7300	5000	4150	3000	2290		
0	9	..	..	..	..	−10%	B	&	B	−10%	..	..	..	..		
						−20%	C	Whitehall	C	−20%					9	0.4
		1650	2150	3050	3650	5300	A	Whitehall	A	4600	3200	2700	1890	1450		
0	7	..	..	..	..	−10%	B	&	B	−10%	..	..	..	..	6	0
						−20%	C	Port Henry	C	−20%						
		1650	2150	3050	3650	5300	A	Port Henry	A	6200	4300	3600	2500	1950		
0.3	7	..	..	..	..	−10%	B	&	B	−10%	..	..	..	..	8	0
						−20%	C	Bluff Point	C	−20%						
		1200	1500	2150	2600	3700	A	Bluff Point	A	5300	3650	3050	2150	1650		
0	5	..	..	..	..	−10%	B	&	B	−10%	..	..	..	..	7	0
						−20%	C	Rouses Point	C	−20%						

[1] Assistant to General Manager for Transportation must have wire notification of all reduced tonnages with reasons therefor.

[2] "Pusher Factor" to find pusher power required to assist tonnage train through pusher district—multiply load power by "Pusher Factor."

[3] Pro rata of E-100 ratings will be used for locomotives not listed above. "A" rating will be used at all times except as ordered by Division Superintendent. Special ratings may be used to meet emergency conditions.

tion of tonnage rating, which rapidly spread over the whole country, this fundamental factor is so often neglected. I happen sometimes on roads where operations are thrown into confusion by trains stalling and not getting in under their limitation time, and find on examination that it is due to the use of the naked formula of application of the tractive power of the locomotive, ignoring entirely the resistance of the cars.

Recognition of the resistance offered by the car led to the recognition of the great economies to be gained by concentrating the load into few cars. I recommended and urged the construction of cars of 80,000 pounds capacity, but this was thought too radical and we started with the construction of 1000 cars of 70,000 pounds capacity. This was followed by the construction of a large number of cars of 80,000 pounds capacity and within a few years cars of 100,000 pounds capacity began to be common. On lines of low grade and where the character of the tonnage permits of heavy loading, it is now not uncommon to find cars of 140,000 pounds capacity in use.

In computing train tonnage I introduced a simple mechanical adding machine that saved much time, insured accuracy of computation and permitted interruption of the process without necessitating repetition, and these in various forms are now in general use.

The method employed in checking up train load in the direction of prevailing traffic on the Delaware and Hudson is as follows:

1. *Average Tons per Train.*—The total number of trains together with the average number of cars and tons per train north from the principal terminals is computed daily from telegraphic operation reports and recorded both in graphic and tabulated form. This information is available at 9 A.M. on the date following the operation and indicates the average performance *per train* of all so-called tonnage trains forwarded during the previous 24-hour period.

On the graph comparison is shown with the performance of the previous month, together with a daily as well as an accumulative average performance for the month to date.

2. *Freight Locomotive Efficiency, Based on Tonnage.*—This information covering performance of previous day is derived daily from telegraphic report and becomes available at 9 A.M. It represents in percentage the relationship between the rating tons and actual tons forwarded from each terminal and is set up graphically. Separate sheets are used for tonnage trains and fast freight trains.

This report differs from the one mentioned above in that any difference in the tractive effort of power used is weighted, while in the average train load report each train unit is considered equal.

3. *Checking Trains with Short Tonnage.*—Within three or four days from the date of performance the conductor's train wheelage and tonnage report for each tonnage train moving in the direction of prevailing traffic is inspected by a competent tonnage clerk and relationship between rating tonnage and actual tonnage ascertained. In all cases where there is a shortage of 70 tons (average gross weight for one car) or more report is filled out and submitted to the superintendent for his investigation.

The expenses incident to handling the trains constitute about 40 per cent of the expenses of operating the road, and, as Wellington has pointed out, until all has been done that can be done to reduce the number of trains required, it is hardly worth while to give a thought to reducing the expenses per train mile. Nor must it be forgotten that the freight business constitutes practically two-thirds of the total business and earns practically all the profits.

To indicate the possible concentrated movement of tonnage in large cars by large locomotives, the Virginian Railway on January 31, 1921, moved from Victoria to Sewalls Point, 126 miles, with a 2-8-8-2 Mallet, in 85 cars of 120 tons marked capacity, weighing light 78,800 pounds each, 13,175 tons lading.

By way of contrast, I made a trip on a special passenger train on June 8, 1905, Chicago to Pittsburgh, 468 miles, in 440 minutes elapsed time, 412 minutes actual running time. The fastest mile was run in 40 seconds. There was one stop

to change engines, one stop for hot box and another to throw out coach, one stop for water, one stop of 12½ minutes because of bursted air hose and new connection on engine. This was the best sustained run of which I have record.

I have elsewhere spoken of the fact that the Class "D" locomotive, 10,520 lbs. tractive effort, would haul more cars from Conway to Wellsville than the Class "H-4" locomotive, 42,160 lbs. tractive effort, would haul from Wellsville to Cleveland. The Class "D" locomotive was an American type designed during the Civil War by Chapman, the master mechanic of the Cleveland & Pittsburgh R. R., a very competent engineer. D. W. Caldwell, who was at the time General Manager of the Ohio Central Railroad and an Assistant Secretary of War, once told me that one day his attention was attracted by the animated wire conversation his operator was conducting and asked what it was about. The boy replied that Chapman's new engine was at Bellaire on its trial trip and the operator there was describing the crowd around it and what he could see of the engine. Caldwell said he thought he would take a look at it himself and ordered it put on the first troop train coming to Zanesville. It was several days later before poor Chapman recovered the pride of his heart. Perhaps if we knew more about the arbitrary things done by the old timers we should not have been so aggrieved by the high-handed conduct of those in the United States Railroad Administration, "drest in a little brief authority," during the World War.

(f) "Per Cent" Rating.—Various methods of rating locomotives in "per cent" for convenience of communications and orders are coming into vogue. My own practice is to show under the cab window the tractive effort in thousands of pounds as a percentage. For example, a consolidation locomotive of 67,000 pounds tractive effort is shown as 67 per cent, while a Mallet locomotive with 111,000 pounds tractive effort is shown as 111 per cent.

185. Assistant Engines.—The use of one or more additional locomotives in moving trains, generally spoken of as "double-header," "helping" or "assistant" locomotives, goes

back to the beginning. There seems to be no agreement as to the relation in which these engines shall be placed. They may be seen coupled together at the head end; one at either end of a train; one in the middle of a train; or both at the front end separated by a few cars only. The first is the practice I have found most satisfactory, especially in taking water and coal. The use of air in braking is under the control of the leading engine. In handling a train with two locomotives coupled together it is usually the practice to rate the efficiency of the second at 90 per cent of its draw-bar pull.

The experiments on car resistance to which I have referred brought out a feature in "double-header" or "pusher" service not generally recognized. When the amount of resistance due both to the rolling friction of the cars in the train and to gradient are considered, two locomotives can haul up a seven-tenths grade the same train that one locomotive of the same type will haul up a three-tenths grade.

The advantages of "double-heading" or the use of "assistant" locomotives are:

1. An increase of the tonnage moved by the train.
2. An increased facility in moving the traffic on special occasions such as snow storms, extremely cold weather, excursions, and blockades.
3. Reduces the number of trains, thus reducing delays, especially on single track.
4. Reduces the expense of trains and of crews, including wages.
5. Permits the use of small and light power which otherwise would be obsolete.
6. Decreases the necessary supply of caboose car equipment.
7. Defers grade reduction by affording a partial substitute.
8. Defers the building of a second track.

In their efforts to "make jobs" the brotherhoods have endeavored to abolish this very economical device, in some states by "legal enactment," with some companies by "collective bargaining." Garrettson, of the Order of Railway Conductors, is reported as stating on March 10, 1903: "The real root of the matter is that while we recognize the right of the company to limit the number of crews by large engines, in other

words, the transporting ability of a given crew, if they get power large enough, we do not recognize the right of the company to limit the number of crews by making one crew handle a train hauled by two or more engines. The essence of this movement is to put on more crews. . . . We make employment for more men." Generally west of the Mississippi the use of assistant engines is prevented on divisions where the ruling grade is less than one per cent. The practice is as old as railroading itself, and should be freely availed of. I have seen assistant engines used to economic advantage on lines of very low grades.

186. Pusher Engines.—It frequently occurs that excellent results may be had in location or in grade reduction by holding the line to a relatively low grade over most of the operating division, bunching the heavy grades in one place and overcoming it with "pusher" or "banking" power, or by "doubling-the-hill." Pusher locomotives are used on many roads with great economic effect, especially if the pusher grade is at the point of departure from a yard and a yard engine can be employed for the purpose.

187. Engine Mileage.—To increase the mileage of engines, consideration must constantly be given to:

1. Averaging the engine rating in the direction opposite to the prevailing traffic upon the percentage which the lesser traffic bears to the greater.
2. Increasing the length of runs.
3. Holding the speed of trains to 20 miles and 12 miles per hour for fast and slow trains.
4. The engine rating.
5. The length of trains.
6. The use of pusher and assistant engines.
7. Reducing road delays and interferences.
8. Reducing terminal and yard delays.

What can be accomplished to increase engine mileage by attention to these details is illustrated by the relative performance on the Pennsylvania Lines West as shown in the following table, an increase of 25½ per cent.

AVERAGE ENGINE MILEAGE PER MONTH

Year	July	August	September	
1895	3257	3385	3287	North West
1899	4276	4181	3951	System
1895	3841	3694	3360	South West
1899	4653	4606	4475	System

This performance, in 1899, was at the rate of 52,284 miles per engine for the year, but with the falling off of traffic in the dull season, the actual mileage obtained was in excess of 51,000 for the year, a record which, I think, few roads have exceeded. We tried a good many experiments, running the coke trains with locomotives over two divisions and securing 5000 miles per engine per month. We also ran some passenger engines between Pittsburgh and Chicago, 468 miles, or at the rate of 14,000 miles per month. I satisfied myself that if a road is properly set up with facilities for coaling, watering, and cleaning fires, long runs may be made to yield large economies. The economies in changing crews without roundhousing the engine should be thoroughly worked out. It is a field pregnant with possibilities. Indeed, so great is now the wastage in train movement due to the restrictions thrown around it in punitive overtime, etc., and the loss of time in delays of power, cars and men, that consideration should be given to the practice of the scheduling of turn-around runs of 1000 miles and over, housing and feeding the crews in a suitable caboose.

When traffic is heavy and threatens to create a blockade, it is often recommended to reduce train loading and increase speed. It is claimed that additional cars can be moved, that the more frequent dispatch of trains relieves the yard, while on roads where break-in-twos are troublesome the lighter trains reduce their number, resulting in better service rendered by crews, less liability to accidents, less damage to power through cooling with the resulting strains caused by expansion and contraction. These claims should be examined with a good deal of caution. The expense is sharply increased.

Walker, writing in 1828, concludes that to increase the speed of freight trains on the Stockton and Darlington Railroad from 3.5 to 8 miles per hour, reduced the tonnage rating (of the 8 horse power engine) from 41.3 tons to 13.5 tons and increased the cost $33^1/_3$ per cent. Jervis, writing in 1858, regrets that there are no exact data to determine the relative costs of different rates of speed. He estimated that the cost of moving a train at 20 miles an hour was no more than 50 per cent of the cost of moving it at 30 miles an hour. A series of tests were conducted by the B. & O. R. R. in 1904 covering some 500 trains, which tended to show that the cost of moving a freight train was increased 150 per cent by increasing the speed from 15 to 35 miles per hour. It is commonly said that if you double the number of trains, you quadruple the number of meeting points. This is a very general statement and disregards the time of day at which the additional trains are to be run and their speed on the road. In this connection advantage may be taken of the delivering time of the freight at terminal. It is a fact, however, that meeting points are substantially increased. On most operating divisions, the traffic is unbalanced and a reduction of 15 per cent in the average tons per train may increase the train density by 30 per cent. Further, much additional work is thrown on the roundhouse and engine dispatching facilities and the Mechanical Department may not be able to turn the engines promptly. Some tests I made with an increase in the speed of only 15 per cent showed a reduction in the tonnage of 34 per cent. It may be stated with confidence that as a rule the relief afforded by a reduced number of trains more than compensates for the slower running speed under full locomotive rating. The net result is distinctly in favor of the bigger load. The sacrifice of known economy in one practice to secure a possible greater return in another presents a nice question to the judgment and must be handled with great caution. The proper handling of the traffic is largely a matter of individual ability controlled by peculiarities of the traffic, road and yard conditions.

Formerly there was much question as to the proper al-

lowance of rest for crews at end of run and length of runs in hours on the road. There was on the one hand the kind and quality of service required and on the other the capacity for sustained effort at maximum efficiency, the legal and moral objections to overstrain, and the choice of the individual to spend his leisure time at his home or to increase his earnings. The diversity of practice on different roads and the different points of view of officers and of men, and the constant effort of the labor organizations to limit output and make jobs, all combined to effect the passage of laws, both State and Federal, by which this matter is now arbitrarily governed. Its rigidity, as may well be anticipated, is at times most uneconomical under conditions not themselves justifying its application.

The time which a train, making a continuous movement through an intermediate yard, is generally allowed for changing locomotives, crews, etc., is one hour. The English in the movement of their collection and delivery business make this change in about five minutes. At Wellsville, Ohio, I used to make the change in eight minutes, the locomotive cutting off with the cut of cars for the lower river division, and the new locomotive backing down and coupling up with the cut of cars that was to be added at that intermediate terminal, the caboose and crew going through. Once in cleaning up a blockade, I had arranged a continuous movement of coke trains through the Fort Wayne yard and had carefully explained to the yardmaster what I expected. He very much surprised me a day or two later by showing me records of trains detained no longer than one and one-half minutes. As the train approached the yard, the caboose was cut off at a distance of about half a mile and brought to a stop by hand-brake before fouling the east leads. The locomotive with the relief caboose, as soon as the train pulled by, backed out on the main track, came up and coupled on the caboose. When the train stopped the road engine cut off and pulled ahead of the west leads, leaving the air brakes set, ran down and backed clear of the ladder; then the relief engine, standing ahead on the main track, coupled on to the train and released

the brakes, testing the air. When the train was set in motion the yard engine acted as a pusher and, by the time the train had cleared the yard, it was going at a smart rate of speed. This was a remarkable and gratifying demonstration of what can be done when you have the confidence and enthusiastic support of the force under you.

I had another experience at this time that may be of interest. On arrival at Fort Wayne, I cleared a space in the yard in order to secure room to work it, by making up three trains of empties, 60 cars each, sending a train of empty box cars north on the G. R. & I. to the ice houses, which were clamoring for them, starting one train of gondolas east over the Grand Rapids and Pan Handle for delivery to mines on the Chartiers Branch, and another east over the Fort Wayne, with orders not to leave the main track until set at the mines on the Chartiers Branch. Later I asked the car service office for a report on these last two trains. They advised that the cars in the Fort Wayne train had been delivered at the mines the following morning before seven o'clock, that of the cars in the Pan Handle train, two had reached the mines at the end of a fortnight, the rest were scattered all over the country. We shall never get any very substantial improvement until we secure system, order and discipline.

At the time I went to the Baltimore and Ohio, that road had on its rails a coke oven development that enabled it to supply one-third of the market. Owing to lack of car supply, a poor road movement and various other causes, it was handling less than 20 per cent of the business.

Having gotten the car supply in shape I systematized the road movement, making up solid trains in the Connellsville district for Chicago, and seeing that from origin to destination, once started, they never left the main track. Engines and cabooses were changed at the customary terminals, but the movement was greatly expedited by the elimination of all yard delays. From having been far behind our competitors we were now well ahead. This "maintracker" movement, as it came to be called by the men, brought back to the road its full share of the business in about six months.

Permanent arrangements should be made to give effect to this advantageous handling. A separate yard, or "bull-pen," with every facility, should be established.

To secure satisfactory mileage there must be a very close degree of coöperation between the officers of the transportation and mechanical departments, an efficient organization of the back shop, engine house and engine dispatching forces, adequate facilities for inspection and repair, systematic inspection and terminal management, close analysis of abundant statistics gathered in the course of handling the engines, stated minimum requirements for the mileage of freight trains daily on the several divisions, and a systematized and regularly observed method of dispatching through freight trains from the principal terminals.

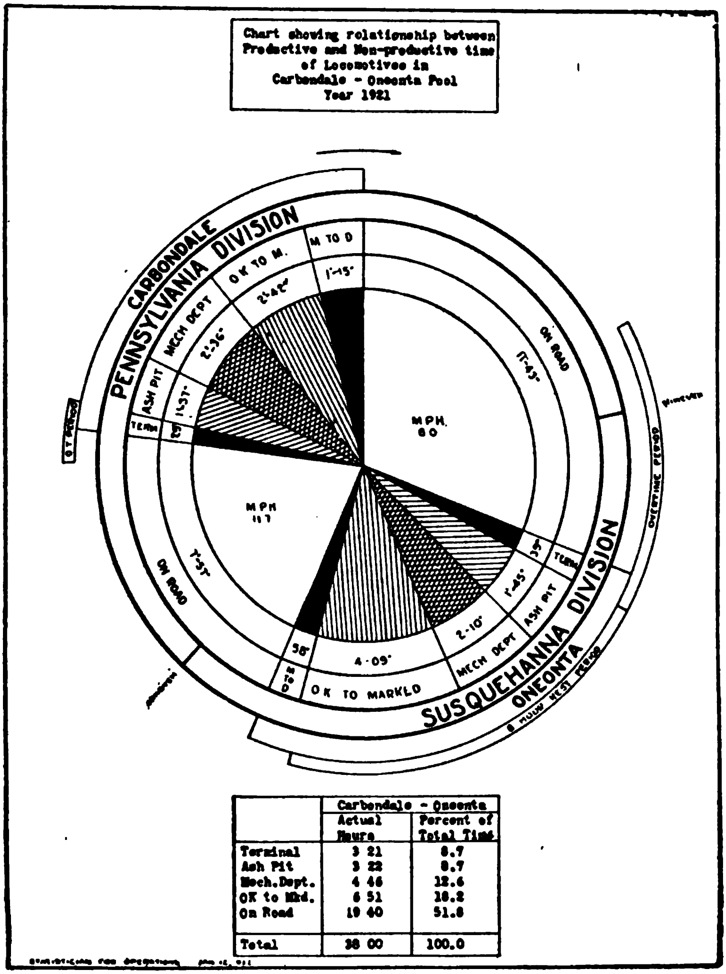
Time is the essential factor in the handling of the locomotive but the hand of the transportation man is not wholly free. There are too many cases where the freight service is practically fixed by arbitrary local or fast freight runs and by branch lines with the traffic too slight to permit variations in schedules.

The peak of the load affects not only the number of freight cars that must be provided but the locomotives and the other facilities also, and this excess investment that must be idle over the greater part of the year (10 months) cuts down the net return.

Figure 63 is a chart showing the relation between productive and non-productive time of freight engines on one of the divisions of the D. & H. during the year 1921. It will be noted that the mechanical department had the power 39.5 per cent of the time, of which 18.2 per cent was holding it for the disposition of the transportation department. The transportation department had it in its possession 60.5 per cent, and of this 51.8 per cent was occupied on the road, of which approximately 30.6 per cent was occupied in actual running.

As illustrating the lack of correlation so frequently met and the need of the most constant and painstaking watchfulness, I noticed one day that preparations were being made

for an exchange of power on the Rock Island between the Denver and Minneapolis Divisions, involving a movement for



	Carbondale - Oneonta	
	Actual Hours	Percent of Total Time
Terminal	3 21	8.7
Ash Pit	3 22	8.7
Mech.Dept.	4 46	12.6
OK to Mkd.	6 51	18.2
On Road	19 40	51.8
Total	38 00	100.0

FIG. 63.—CHART SHOWING RELATIONSHIP OF PRODUCTIVE AND NON-PRODUCTIVE TIME.

each engine of some 846 miles. The reason was given that the bridges on the Denver Division were too light for the power. As I was in a few days to go over the Division, I

put the papers in my pocket and instructed the division engineer to go over the division with me. He advised that the only trouble with his track was lack of ties on one of the curves, and walking over it confirmed his judgment that a carload of material would overcome the defect. "So great a fire a little matter kindleth."

There is no more economical investment than power well kept up. It is by far the largest element in fuel economy, firing being small beside it.

All engineers are familiar with the length of time necessary to get a freight locomotive, either light or loaded, under headway and, when running, to bring it to a stop. It would seem as though it were possible greatly to improve this situation, especially by the use of "boosters" in starting and accelerating trains to speeds of from 15 to 20 miles per hour, and by working compound engines as simple engines where adhesion can be maintained, while greater stopping control over large and high-speed locomotives may be provided with improved brake shoe design, material, flexibility and bearing area in combination with clasp types of brakes for all wheels.

The proper systems and time for washing out boilers and the supplying of suitable, treated if necessary, boiler water to adequate tender tanks will dispose of "water causes."

Through the installation of modern fuel-preparing facilities, provision for adequate tender capacity, adaptation of locomotives to burn the most inferior and cheapest fuels available, use of simplified manual means of firing, and particularly by reducing the consumption required per boiler horsepower developed, the "fuel causes" can be substantially reduced.

Many facilities for fueling locomotives, either with coal or oil, are obsolete, inadequate and uneconomical. Fuel should be prepared ready for firing before being placed on tenders, and with modern facilities practically no time should be lost in supplying them, either on the road or at terminals.

Watering is usually performed at the same time that fuel is taken, or water is supplied from track troughs when running, or from track cranes when making station or train-dis-

patching stops or at terminals, and should involve little if any delay.

"Man causes" can best be avoided through the employment of competent men and the inauguration of proper systems of instruction, and by equipping locomotives in such a way that they will require the least amount of arduous work, leaving the engineer and fireman free to devote most of their time to the observation of train rules and signals and to the proper regulation of the mechanical appliances for saving time, fuel, water and labor.

In the operation of locomotives, the Hours of Service Law, as enacted by Congress on March 4, 1907, established the general practice of pooling locomotives and crews, a system which until that time had been adopted by only a few of the railroads. The divorcing of the engineers and firemen from regularly assigned locomotives, in combination with the increasing size of the latter, resulted in relieving the enginemen of work which was transferred to the enginehouse forces, such as detailed inspection, adjustment of driving-box wedges and main and side-rod brasses, repacking boiler-head fittings and journal cellars, filling grease cups, cleaning head, cab and marker lamps and various other equipment and parts, filling lubricators, looking after tools and supplies, hostlering at terminals, and similar detailed attention, which, in combination with the more extended use of power-operated brakes, reverse gears, ash pans, grates, stokers, coal pushers, water scoops, fire doors, bell ringers, cylinder cocks and like devices have practically eliminated arduous manual operation on steam locomotives of great power.

The mechanical requirements and status of the engineer and fireman on large steam locomotives having been substantially changed through relief from long hours on the road, through the work done at terminals and by means of these labor-saving devices on the road, there should now be a resulting higher standard of operation, efficiency and economy.

188. Engine Failures.—The New York Public Service Commission specifies that all delays of over five minutes to a passenger, express, mail, milk or mixed passenger and

freight train, or over 20 minutes to a freight or work train, or to a locomotive running light, or in switch or pusher service at the time of the failure, whether due to poor fuel, bad water or inexperienced enginemen, or other causes, constitute an engine failure.

The inspection service has some 200 classifications grouped under eight different heads:

1. Boiler failures and fire boxes.
2. Hot bearings.
3. Air brake failures.
4. Machinery failures and others.
5. Valve motion.
6. Cylinders and steam connections.
7. Injectors.
8. Connecting rods, side rods and wedges.

Inspection is usually made by a regularly assigned locomotive inspector. These inspectors are not employed to exempt enginemen from looking over their engines, but merely to supplement their care. It is highly essential that enginemen should report such necessary work as can best be observed while the engine is in motion, such as defective injectors, pops not relieving, air brake troubles, valves out of square, etc. Upon systematic and regular inspection of the engine while at rest depends in great measure the success of the engineman as a runner and his exemption from trouble. Safety is to a great measure dependent upon his care and foresight and the assurance that the locomotive is in perfect condition before the journey begins gives him a wonderful degree of comfort and confidence.

A thorough examination of all the machinery and running gear can best be made while the locomotive is standing over a pit. Attention should be given to engine truck with its bolts and pins, the oil box packing, pilot-braces, cotter keys and all their connections, the eccentrics, eccentric straps and blades where the link motion is still in use, the wedges and binders; and outside to the valve gear, guides, crossheads, rods, rod bolts, tires and flanges; and especially

to the boilers and fire boxes to detect leaky seams, stay bolts or flues.

189. Yard Work.—In making up freight trains for movement into the terminal where delivery is to be made advantage should be taken of the consignee's habit of not working on Sundays or during the night. For this purpose, cars set on his siding, on the team tracks or at the freight house at 7 A.M. Monday morning do as well as though they reached the terminal at 10 P.M. on Saturday evening. Full advantage taken of this condition will permit of cars being switched together and held for several hours at the next preceding terminal and solid trains may thus be built up, cars switched in delivery district, order and time and money saved at the delivering terminal.

The most efficient system in making up trains is that which reduces to a minimum the aggregate time required to pass through the various yards from which trains are dispatched. Three systems are in general use:

1. A classification is established common to all yards; the grouping of cars together in accordance therewith is begun in the initial yard, and continued in each succeeding one, adding to each group such cars belonging thereto as have been picked up since leaving the previous yard.
2. At the first intermediate yard through which passes sufficient traffic for any one point, make up solid trains so far as possible for that point, forwarding the surplus without classification to some further point for distribution.
3. Make no classification until the first yard of the run which makes a delivery of the cars is reached.

While the first method is often very effective, I have generally used the second and under it I have known of a reduction in yard detention in movements over three divisions from between four and seven days to one and one-half days.

Regularity is the key-note in maintaining a satisfactory result in car miles per day. Trains should be built and dispatched from the larger terminals on consistently constructed schedules and kept on time. If this could be half-way accomplished we should be figuring on the next progressive step in keeping a larger per cent of through cars off the humps

and out of the yards by giving them a main track or "bull-pen" movement.

Young men seeking employment with railroads dislike to take positions in terminal yards, as the pay is small, the hours long and the work very exacting. Yet no one expecting at some future time to occupy the position of agent of a terminal station can afford to neglect the work. Here is the first round of the ladder, and a person familiar with the small details can handle the general business to better advantage. It is a wide field and I know of none better suited for a young man making his start in railroading.

As a yard begins to congest, a careful canvass should be made of the power; the engines in shop or awaiting shop should be inspected and work concentrated on those that can most promptly be restored to service; the crewing and assignment of the engines should be gone over; local and other freight locomotives should be thrown into links or pools; work train service should be curtailed or stopped entirely; road engines in use in yards restored to road service; the engine rating reviewed to determine whether a change is justified, and the functioning of the engine dispatching facilities scrutinized to insure avoidance of delays; extreme care taken to avoid "holding out" arriving trains, as an average delay of four hours may call for the use of 30 per cent more road locomotives; and attention given to the instant dispatch of trains from the yard when ready for movement.

The work of the yard reflects the supply and use made of road and yard power and its layout and facilities. While we speak of the large terminal as a yard, it is, as we have seen, a collection of several yards, and in its working should be regarded as such, the liaison between its several components being affected through the general yardmaster. Aside from its construction, which is too often upon a poor and inadequate design, frequently failing in the provision of some essential feature, the greatest defect in its working is the time cars are held, and every effort should be made to insure the prompt flow of the traffic through these reservoirs.

The general yardmaster, with his night yardmasters, and the assistant yardmasters, has, in the larger yards, a very considerable staff. The chief clerk, yard clerks, bill clerks, report clerks, the men in the register room, the crew dispatchers, callers and switch tenders, all with personal and interrelated duties, keeping records, making out forms and reports and actively engaged in a swiftly moving business of many details, should be chosen, trained and supervised with the greatest care.

A review of the work undertaken by the crew dispatchers will serve to show the general character of these activities. They supervise and assist in calling all crews and marking up the crew board, keeping it always up to date. They see that all members of crews report on time and examine register sheets and see that the registers are correct. They check the register sheets with the time slips, delivering to the general yardmaster the time slips claiming pay for services not actually rendered. They check the forms, noting to the general yardmaster any undue delays. They post the notice of positions advertised and given out. They also post and care for the general orders. They check up the watch certificates. They are charged with keeping the records of register room business up to date. For extra crews called they make out and submit to the conductor a caboose form, or for the extra crew for passenger service, the train box form. The crew dispatchers are in constant communication with the train dispatcher's table through the medium of a private telephone line and with the chief train dispatcher through a separate telephone line. They also have the shop telephones which keep them in touch with all parts of the yard and the outside city telephone.

Many of the practices are stereotyped and simple, but some are of the first importance and need the most careful attention; among these the handling of messages. With the use of the "three-copy" system, messages are seldom forgotten, overlooked or lost. The telegraphers are instructed to make out three copies of all messages addressed to the yardmaster. One copy of every message is placed on the

message file on the general yardmaster's desk. If the message relates to the calling of crews or anything pertaining to the register room, a copy is placed on the crew dispatcher's desk on the file marked "current messages." If the message relates to coaches, private cars, baggage cars or any coach-yard business, the third copy is placed on the current file of the assistant yardmaster. If the message relates to freight movement, this third copy is given to the chief clerk, who in turn hands it over to the yard clerk for action. This system allows the general yardmaster to know at a glance the current orders involving his force and he can at various times check up his force relative to these orders, noting on the bottom of the message what action has been taken. Each person involved likewise makes note on his copy of the message what action has been taken. At the end of each day the dead messages are taken from the current file and filed away, those from the general yardmaster's file according to date and the others according to subject.

The yardmaster should keep a book or log, in order to insure coördination between the day and night forces and to eliminate the failure of one force to leave proper records to the other. In this book at the end of each day should be entered a statement of the situation of the yard, together with notes of any special orders received that are to be carried out during the night. Rush cars, perishable cars, milk cars or any other cars requiring special attention during the night are noted. The same thing is done at the expiration of the night trick. The night yardmaster also enters in this book a detailed report of his night tour, paying special attention to any extraordinary happenings and in case of accidents, derailments, etc., he leaves the information for the compiling, by the day force, of the necessary forms.

The power for yard service is apt to be much neglected. I favor the practice of converting road locomotives for this service but only on condition that it be most carefully done. The frame should be properly weighted to restore the balance lost through the withdrawal of the pony truck, or what is

usually better, a new frame supplied. The radial axle-box designed by Webb in 1876, or some similar device to allow a lateral motion of three-fourths of an inch to the axle on either side of the center line of the locomotive, may be applied to relieve the thrust on the frogs. Care should be exercised to have the tires turned up to avoid abuse to the frogs, and generally the yard engine kept in high class condition.

Switching mileage affects locomotive economy quite as unfavorably as empty mileage does freight car movement. As the tonnage moved grows, the switching mileage grows at an increased ratio. For the year 1919, for Class I roads, it was:

SWITCHING MILEAGE

	Eastern	Southern	Western	United States
Freight locomotive mileage.........	258,890,945	111,275,468	253,781,759	623,948,172
Switching (road and yard) mileage....	175,103,029	50,742,766	110,171,973	335,917,768
Per cent of switching	68	46	40	54

On some roads the per cent of the switching mileage runs as high as 80 per cent.

There is large opportunity for the saving of switching mileage by competent supervision. Observe particularly the changing of crews at outlying points, avoiding the lost time running to and from the engine house; the rearrangement of sidings and provision of facilities—public, private and company. The timing of the yard engine by the use of the "Servis" recording device indicates that these engines are usually employed in active motion only from 40 per cent to 60 per cent of the time in service, and a study of the indications of idle time given by this device shows the possibility of filling up the gaps with useful work.

Great care should be exercised in the preparation of the train for its journey on the road. Before it finally leaves the yard there should be a systematic inspection of journal

boxes, seeing that they are properly lubricated, brasses tested, brakes and their rigging looked over. The yardmaster should make sure that everything is as the sailormen say "Ship-shape and Bristol fashion."

190. Road Work.—By reason of the nature of the traffic, live stock must be moved by itself, dressed beef and perishable freight must be moved on fast schedules, and consideration must be given to the movement of slow freight, mineral traffic, empties, etc. Competition between the railroads in the matter of the speed of freight trains is exceedingly expensive and it would appear that they might well adopt in this service the practice long since worked out in the passenger business between Chicago and New York, where 28 hours was agreed upon in 1893 as the normal movement and a proportionate excess fare charged upon all trains with more rapid schedules. Sometimes this demand for fast movement in freight service is virtually confined to the movement in one direction, and in that case care should be exercised to avoid it in the direction not needed.

191. Local Freight (Mixed Train).—Unless relieved by a "drop and pick-up" freight the "local" will have to do the station switching at intermediate stations, as well as handle the package, or L. C. L., freight, to and from them. This run is usually popular, as it is made in daylight with high rates of pay and Sunday at home, and carries a large crew to handle the goods. It should be in charge of a seasoned conductor of painstaking habits and good personality. I once tried the experiment of running a night local out of Pittsburgh to meet the competition of the Ohio River boats and it worked so well, in avoiding interference with other trains at hours of heavier movement, that I think it might well be tried out of many of the larger terminals. On lines of thin traffic it is customary to place a passenger coach on the local freight making the same a "mixed train" and the complementary practice is often followed of placing a car of high class or perishable freight on a local passenger train. I once carefully analyzed the L. C. L. work done by the local between Fort Wayne and Crestline, 132 miles,

and, putting an extra baggage car on an accommodation train, with freight conductor and crew in charge, and lengthening out the schedule of the run one hour, handled the L. C. L. business for the district. At Lima, where the passenger and freight stations were in separate buildings and some distance apart, the freight was moved from the one to the other by a drayman. The expense of an entire train movement in each direction was saved and the business greatly expedited. It would seem that there are many places where such an arrangement could be installed. Perhaps it would be more easy to introduce this practice if the proposition were presented in another way, namely, relieve the local freight of the handling of any carload business and attach one or more passenger cars with a train auditor to handle the passengers and their fares.

About 40 per cent of the L. C. L. freight is brought to the large terminal stations in the morning. The greater part, however, is delivered quite late in the afternoon, usually about 60 per cent after 2 P.M. On the work of receiving clerks and callers, or checkers, largely depends the prompt and proper handling of L. C. L. freight outbound. For these positions the best class of men should be secured, usually by promotion from the truckers. The callers, or checkers, come in direct contact with the teamsters and have to read the marks on the packages. The inbound freight also requires particularly good men for callers, checkers and delivery-men. The time spent in unloading teams averages 20 minutes.

Houses usually open at 7 A.M. and close at 5 P.M., which enables freight to be pulled at 6 P.M. Not only should cars be loaded in station order on the tracks and placed in the same positions each day, but the shippers should be educated to load their drays so as to keep shipments together.

In 1906 it was estimated that the cost of handling in-freight was 40.03 cents per ton, out-freight 34.90 cents per ton, being a ratio of 7 to 5 and an average cost for both of 37.04 cents per ton, while team track tonnage cost only 3.34 cents per ton. The principal reason for the greater

cost of handling inbound freight is the failure of the consignees to take their freight away promptly, resulting in cluttering the platforms and houses and sometimes increasing by as much as 40 per cent the cost of handling inbound freight.

A frequent rule in regard to the use of the local freight trains for distributing company material is that not over one hour per train daily should be so consumed, placing the train at the disposal of the division engineer to that extent.

If the local train has to handle carloads, the L. C. L. cars should be kept next to the caboose so that the engine may cut off ahead and do the station switching while the crew is handling the L. C. L. business.

Because, on many roads, there is a decided preponderance of empty cars moving in one direction, the practice of very light loading of cars in that direction is indulged in, especially with L. C. L. freight. Not only does this work a great hardship to lines over which they may pass in the direction of the heavy traffic movement of such lines, but it greatly increases the cost of terminal handling and lowers the morale of the men. The rule should be—get all the load in the car that can be got, subject always, of course, to such limiting conditions as exist.

Data assembled by the American Railway Association indicate that the average loading of L. C. L. cars, for the 142 roads reporting, was 16,712 pounds in March, 1918; 14,722 pounds in March, 1919; and 16,182 pounds in March, 1920, there having been 849,796 cars of such freight loaded in the latter month. The average loading of L. C. L. cars on the Delaware and Hudson in March, 1920, was 22,108 pounds. If this figure had been reached by all roads in the country, 227,789 cars would have been released, and if that road's performance in February, 1918, had been attained (26,895 pounds per car), it would have resulted in a saving of 338,497 cars.

The L. C. L. tonnage amounts to about 4.5 per cent of the total tonnage handled and requires for its handling,

due to light loading, about 23 per cent of the country's freight cars. The business, by reason of the expense of handling at each end of the journey and at transfer stations, and by reason of the low tonnage loading of the cars used, earns little or no profit, particularly in view of the expensive character of the facilities required, the high cost of lands in cities and the expensive buildings and large accounting force necessary. This is one of the most important fields of study in the economies of freight transportation.

192. Drop and Pick-up Freight Trains.—Where the traffic will warrant, a "drop and pick-up" train should be run in each direction over the district. This train will relieve the "local" of the carload switching at the stations, distributing all cars, both loaded and empty, billed or moving on orders of the car distributor, and will bring into the terminal cars set off for bad order, or to lighten tonnage to avoid the 16-hour law, and especially cars carrying "fast freight" cards. In such trains the "fill outs" should be kept next to the caboose, making their handling unnecessary in doing station switching.

Where the business justifies, two drop and pick-up trains are run, one to handle first-class stations and the second to cover all other stations.

193. Time Freight Trains.—Time freight, slow, or drag freight scheduled at about 12 miles per hour constitutes the bulk of the railroad business and is the chief source of its income. It consists of raw materials, minerals, lumber, grains, building material, machinery, low class merchandise, etc. Very much more effort than is now made should be exerted to keep in motion cars in this service. The delays from many causes are exasperating and expensive and on the road are greater than should be tolerated. Systematic effort to improve the condition of passing sidings, water stations, coaling stations, track conditions, etc., is needed. It is not infrequent to find the number of telegraph stations, and the distance between them on adjoining divisions differing as much as 25 per cent. Before the Civil War we find D. C. McCollum, then of the Erie R. R. and later General

Manager of the U. S. Military Railroads, saying, "I would rather have a road of a single track with electric telegraph to manage the movement of its trains than a double track without it." We ought systematically to canvass all our facilities to make sure we are provided with the very best procurable.

194. Preference Freight Trains.—The more the "preference freight," the less the preference. Preference movement is usually classified as follows:

1. Perishable freight and live stock.
2. Less than carload freight.
3. Carload freight requiring extraordinary movement.

Every effort should be made to keep this third class to a minimum. To care for these freights there should be two movements: (*a*) disc movement, on a regular schedule as fast as necessary and rigidly maintained; (*b*) symbol sticker movement—a preference movement through the yards in time of congestion.

Preference freight is often much delayed through putting slow freight in fast trains and through taking slow freight into yards in advance of preference freight, which is thus held out of the terminal or delayed in its movement.

Preference freight unfavorably affects the economy of movement. The train tonnage is reduced about one-third. Power has to be held for the movement, reducing locomotive mileage. There is also considerable delay to slow freights side-tracked or held to allow the fast freights to pass.

195. Fast Freight Trains.—There has grown up a very considerable movement of freight on a quickened schedule spoken of as " fast freights," "manifest freight," "symbol trains," "red ball trains," etc., moving at a schedule speed of about 20 miles per hour. The traffic consists of perishable articles or goods of high value: live cattle, refrigerated meats, dairy products, fruits and garden truck, milk and other expensive merchandise. The tonnage that can be moved at this speed is about one-third less than is moved on the so-called time freight or slow freight, scheduled at

about 12 miles per hour. Very great care is taken to watch this movement in all its details. The waybill or manifest is printed in a distinctive color or carries a distinctive mark; the card carried on the sides of the car is identically printed or marked. The movement instead of being solely in the hands of the division people is carefully watched and supervised in the office of the superintendent of transportation. Discs, one representing each car in the train, are hung on a board and this board is moved in a frame from point to point as the train proceeds on its journey. Should a car be set out for defects, the manifest is left with the agent, the general office notified and a reminder card hung and retained conspicuously until the car is again in motion. Various systems are in vogue for supervising this service, to prevent damage and consequent loss from delays, and also to reveal the character of the movement over different divisions and through different terminals and the competency of officials. These trains because of their high rate of speed are much more expensive to run and should be canvassed with great preciseness as to their justification. There is also a great deal of abuse in making up of the tonnage fill-outs, much slow freight being moved in them as a means of obliging shippers or securing business.

196. Detouring.—At the Eleventh Annual Meeting of the Car Accountants Association held at Buffalo, N. Y., June 15, 1886, resolutions were adopted and submitted to the General Time Convention, looking to the uniformity of reports and future action covering record of switch cars, reporting mileage of line cars and a uniform rate of passenger car mileage. This communication was referred to a committee of five by the Convention of October 12-13, 1886. The committee appears to have selected its own title, calling itself the Committee on Uniform Car Mileage Reports.

Subsequently communications were received from the Car Accountants' Association and from the Association of North American Railroad Superintendents at the convention of October 12, 1887, and referred to a new committee, called the Committee on Car Mileage and Per Diem Rates. At the

meeting of October 9, 1889, this committee was, upon the recommendation of the executive committee, made one of the standing committees of the convention, with the title of Committee on Car Service.

At the convention of October 10, 1888, the committee recommended and secured the adoption of a uniform rate per train mile for any trains using other lines in avoiding washouts and other obstructions. The charge was fixed at 50 cents per train mile for either passenger or freight trains handled by their own locomotive and crew; together with the actual cost of pilotage, and with fuel and incidental supplies at cost plus 10 per cent, and water at 50 cents per tank. At the meeting of November 16, 1910, the charge was advanced from 50 cents to one dollar per train mile, and for movements in which home company supplies and locomotives, enginemen and firemen are used the rate was fixed at two dollars per train mile. The last change was made in November, 1920, when the rates were fixed at $1.50 and $3.00 respectively.

The question of responsibility in the risk of accident to the owning company, to its trains, cars, contents, passengers and other third persons, while detouring on the tracks of the other company, regardless of whether such accident was due to defective track or cars, or to the neglect, carelessness or act of its own employees or others came up for discussion. Finally, at the meeting of October 25, 1905, a Standard Form of Detour Contract was adopted and later amended and made effective January 1, 1911. Under this arrangement the "Home" company (the company whose tracks are used) may, but is not obligated to, grant permission to use its tracks. Granting the accommodation does not warrant or imply the insurance of the "foreign" company's (the company making the detour) trains against any of the risks of transportation, nor the assumption of liability therefor by the "Home" company, the "foreign" company must provide crews familiar with the standard code, must use a pilot furnished by the "home" company and be subject to all the rules and regulations of the "home" company and

the orders of its train dispatchers. Disputes arising out of the detour are to be referred to the Committee of Transportation of the American Railway Association for final and binding disposition.

There should be kept in the office of the chief dispatcher and trainmaster carefully prepared charts showing all the detour lines available for each operating division of the road with such information as may be necessary as to their grades, curves, strength of bridges, clearances, etc., which may be immediately consulted should occasion arise. Some general limitation of advisability of detouring should be adopted.

197. Standard Time.—No single element enters into freight transportation so continuously, so pervasively or with such vital importance as that of time. Not only are the train movements related to time but their safety is dependent upon its exact observance, while in the conduct of transportation it is essential that all regulate their conduct with reference to the same exact standard. To insure this, reference was had in the early days, for one or more operating divisions, to the passage of the sun at noon over the meridian at headquarters or at some prominent city on the line.

As communities increased and the railroads grew both by extension and amalgamation, great confusion and inconvenience resulted. Three kinds of time were in use at New London, Conn., and such experience was common. The time at the meridian of Columbus, Ohio, was used over a territory from a point in the east where local time was 16 minutes slow to a point in the west where local time was 29 minutes fast; the time at the meridian of Jefferson City, Mo., covered a district with an extreme difference of one hour and six minutes; while one long line running northwesterly and southeasterly used six different standards.

In the ten years 1870 to 1880 the number of standard times used by the railroads had been reduced from about 70 to 53. Yet these intersected and interlocked each other and were an abomination and a nuisance governed by no principle which would enable a person familiar with them in one locality to judge of them in another. Absurd paradoxes sometimes

occurred, messages from east to west between near-by points being received apparently before they were sent. So great an inconvenience was, of course, a matter of much discussion and complaint.

Prof. Chas. F. Dowd, of Saratoga, N. Y., had in 1870 published a pamphlet entitled *System of National Time for Railroads,* and later plans to the same end had been brought forward by Fleming, Hill and Abbé. In 1877 an arrangement had been worked out by the Western Union Telegraph Company and the Naval Observatory at Washington by which time was signaled and a "time ball" dropped at the top of the former's main office building that was visible all over lower New York City and its harbor, and was much used locally and by the shipping interests. I well remember being with my father on lower Broadway when he stopped and set his watch by this "time ball," he having theretofore depended upon the chronometer in the show window of Benedict's at the corner of Broadway and Cortlandt Streets.

This indicated a method by which uniform time could be maintained throughout the country, and at the meeting of the General Time Convention of October 13, 1881, on motion of E. B. Thomas, the whole matter was referred to the secretary with instructions to report thereon. W. F. Allen stood in very much the same relation to the standard time movement as Morse did to the electric telegraph. The scientific theory upon which the system was based was well known; what was needed was the presentation of the system in such shape as to convince practical men of its feasibility. This Mr. Allen, after a truly immense amount of work, did, and the system was adopted and put into effect at noon on November 18, 1883, throughout the United States.

Not only had the 113,000 miles of line to be brought into uniformity but all the many communities had to be persuaded to its use. This was much helped by the publicity given the matter through the discussions in the *Century* magazine in the department "Topics of the Time" and by the activities of some of the learned societies, by the active canvass of the railroad officers, but principally by the action of the City

of New York, which exerted a powerful example by changing its time four minutes.

I well recall the Sunday morning when this momentous change was effected. I was then division engineer for the Pennsylvania Lines at Logansport, Indiana. We had talked with many of the people of the town and had written articles for the local papers, and as a last precaution had divided up the names in the telephone list among our group and had called up personally every subscriber and urged the change in his clock at noon.

For a few years some places located about midway of the standard meridians disregarded standard time for home use, retaining their old diverse local times. These gradually abandoned the inconvenient practice and use of standard time has become almost universal, Detroit being an exception. During the World War throughout the United States, and since in restricted localities, the so-called "daylight saving" time has been used in summer. No one has, however, thought it possible to employ any variant unless for a full hour's difference and its relation to standard time be well defined.

In its practical application standard time was covered by six of the uniform train rules. It was telegraphed to all points from the general offices at 4 P.M. central time, daily. Standard clocks were designated and time was taken from them. The five-minute variation allowance was abolished on the Pennsylvania Lines on December 1, 1883. Conductors and engineers were required to have reliable watches, examined and certified to by responsible watchmakers, and able to run within a variation not to exceed 30 seconds per week.

Upon inspection a large percentage of the watches previously in use were found to be unfit to run trains by. In those days there was on almost every road at least one negro in the train service. Usually these men had hung about the yards making themselves generally useful and "fagging" for the crews, until on some occasion of shortage they got on the payroll and then worked up. We had such a man on the Indianapolis Division who had come to be a freight engineer and a very good one. He had saved his money

and bought a watch, quite the pride of his heart. It failed to pass the watch examiner and one of the men asked him if he was going to buy a new one. "Sure I am," was the reply, "do you know any other road where a nigger can get an engine?"

At first, examinations were made by local watchmakers. Several attempts were made to organize an Inspection Service. The Chicago, St. Louis and Pittsburgh Railroad (a part of the Pennsylvania System), in consultation with three experts selected from among local watchmakers, took the matter up in the early part of 1887, with very satisfactory results. It was conceded that a perfect time piece was out of reach of the men, even if obtainable at all. It appeared that a movement which would probably not vary more than 30 seconds per week could be purchased for from $30 to $50, and as all men had access to standard clocks, set daily, it was deemed that so much variation could be allowed with safety, and that figure was fixed as the standard. Quarterly examinations were decided upon because in the experience of the three watchmakers, watches, especially engineers', could not be trusted to remain clean and reliable beyond three months. The method of examination was to appoint as inspector some resident and reliable watchmaker at the end of each run; these inspectors to examine and report upon all watches taken to them with a request from the superintendent to do so. At the superintendent's office was kept a record of the watch carried by each man, and as often as necessary he was sent to one of the watchmakers with a certificate to be filled out. The road paid for all examinations except in cases where a watch was found by the examiner to need cleaning or repairing, in which event the employee was obliged to provide himself with another movement (termed "borrowed watch") to use while his own watch was undergoing repairs, and for this loan a fee was assessed by the inspector against the employee.

The company had not gone into the details of watch construction at all, either as to adjustment, jewels, magnetic shields or otherwise. All road and yard conductors, en-

gineers and flagmen (rear brakemen) were required to carry standard watches.

About 1892 a more comprehensive plan was finally given real effect by Webb C. Ball of Cleveland, who gradually organized a service which now takes in the bulk of the railway mileage of the United States. No one perhaps did more than Mr. Ball to improve the character of the time pieces in general use. When he took up the work the watches were 15 jeweled, single roller, escape wheel, flat hair spring, not adjusted, fortunate if they ran within 30 seconds, and most of them key-wind. To-day the watch is double roller, steel wheel, sapphire pallets, Brequet hair spring, adjusted to temperature and five positions with practically a ten-second limit and stem wind. This watch sells for less to-day than the old-fashioned key-wind watches 45 or 50 years ago.

With growing confidence in the time service and the removal of the restriction of five minutes for variation of watches which had been placed on superior trains, the entire train service felt the stimulus of the new conditions. It was recognized, however, that more than an ordinary effort must be made to secure accurate time, and recourse was had to the United States Naval Observatory at Washington. This station had been maintained for more than 40 years to provide the navy with an accurate standard of time. Every day, unless the sky was so obscured as to prevent the use of the instrument, observations are taken upon several stars with a large fixed transit instrument and the sidereal time carefully deduced. By means of a chronograph, working automatically, this time is compared with a clock set to mean time at Washington, which is rarely changed, but its differences from time to time are daily observed and noted, and from this clock by the same automatic means another clock is set and kept upon absolutely correct time of the 75th meridian. This last clock is the transmitter, which is connected with the Western Union system of wires.

That the length of line through which the signals are given does not affect the exactness of the time transmitted is shown by the experiment of a metallic circuit from Boston to San

Francisco and back, the time required to make circuit of which (7000 miles) was less than half a second.

198. Uniform Train Signals.—Encouraged by the joint action of the roads in adopting a standard time, James McCrea, at the meeting of the General Time Convention of April 11, 1883, called attention to the lack of uniformity in train signals and offered the following resolution:

> RESOLVED, That a committee of five be appointed by the chair to report to the next convention on the subject of uniform train signals.

The motion being carried, a committee was appointed with Mr. McCrea as chairman.

The committee first exhaustively investigated the practice on the principal roads of the country. It then classified the signals and determined the fundamental principles involved in their formation and use. They laid down the conclusions that hand and lamp signals should be so plain as to make it impossible to misunderstand or confuse them; that so far as possible no signal should be made to convey more than one meaning, and that signals should be exhibited in the location which will make them the most plainly visible, and for the longest time, to those for whose information they are displayed.

The committee found a great variety of practice on the different roads in the use of signals, hand and lamp, bell-cord, whistle, stationary and fixed, and torpedoes. This confusion had led to some accidents and was the cause of general uneasiness and complaint. They recommended the abandonment of a great many signals, the whistle signals being reduced from 26 to 13. They found the greatest difference of opinion to exist in regard to the hand and lamp motions, and were guided in their assignment of the "up and down" motion by the fact that it is one more likely to extinguish the lamp than any other. They were embarrassed by the fact that there were then available only three colors of any practicable value in giving signals, namely, red, green and white. They defined the rear of the train as the part

that, when the train is proceeding in its authorized direction, will pass over a given point last, and provided that markers should be displayed on that part, and no train should be reported or considered by until the markers are seen. In this connection it is well to note that the lamps carried on the rear of the train are combination lamps, the red signal for rear protection, the green signal the marker; under the present practice while the train is on a siding the green light is shown to the rear to indicate that the train is not occupying the main track. The committee also recommended classification signals.

The work of the committee was comprehensive and thorough, and evidenced careful consideration and full grasp of the principles and practices involved. Its report was adopted to take effect November 16, 1884, and continues in effect to this day substantially unchanged.

199. Standard Code of Train Rules and Telegraph Orders.—The General Time Convention now undertook a work that was to be its most ambitious and useful accomplishment. K. H. Wade at the meeting of October 9, 1884, offered the following resolution:

> RESOLVED, That a committee of five be appointed to submit a system of Uniform Telegraph Orders and General Rules for governing train service

and was appointed Chairman of the Committee.

As has been noted, the movement of trains by telegraph orders had been originated by Charles Minot upon the Erie Railroad in 1851, and rules of various sorts had grown up on the several roads. The Pennsylvania Railroad had issued a Book of Rules in 1874 that was to become the foundation of what is now the A. R. A.'s Standard Practice. It was the work of a committee composed of Cassatt, Thomson, Pitcairn, Wilkies and Baldwin. The work in detail was largely that of Wilkies and Pitcairn. Wilkies, who was a civil engineer, a graduate of Rensselaer Polytechnic Institute, may fairly be regarded as the father of the rules in general railroad service to-day.

The committee brought in for discussion a preliminary report at the October, 1886, meeting. It had held ten sessions in different parts of the country occupying 21 days. It had examined the rules in use on all the important roads and had had before it many of those recognized as experts in this practice, as well as conducting a widespread and voluminous correspondence. It had further incorporated in its report the work of the Committees upon Standard Time and upon Train Signals.

The committee had been enlarged by the inclusion of some southern representatives upon the amalgamation with the Southern Time Convention, and was then composed of:

K. H. Wade, Chairman, and General Superintendent, W. St. L. & P. Ry. Co.
E. B. Thomas, General Manager, Richmond & Danville System.
H. B. Stone, General Manager, C. B. & Q. R. R. Co.
H. Walters, General Manager, Atlantic Coast Line Ry Co.
William Rodgers, General Superintendent, Central & S. W. R. Co. of Georgia.
C. D. Gorham, Superintendent, N. Y. C. & St. L. Ry. Co.
R. Pitcairn, General Agent and Superintendent, Pennsylvania Railroad Co.

The committee advised that it had adhered to the principle of securing both the highest degree of safety and the largest measure of efficiency; and that all roads might adapt the rules to their local circumstances, while strictly conforming to the general principles and practices laid down.

Great care was observed in the language of the rules; they were submitted to the legal departments of several companies and their suggestions considered; they were passed upon by a distinguished grammarian and the language of the rules was believed to be fully within the comprehension of any employee.

The committee was strongly impressed with the importance of the adoption of absolutely uniform practices in regard to running trains and telegraph instructions.

The report of the committee was submitted by it for discussion at the meeting of October 25 and 26, 1886. Each

rule was read and passed upon, proposed amendments considered, and the Committee interrogated as to their understanding of many of the rules. The committee expressed itself as most solicitous that every opportunity be given for full and free discussion and that all members have an opportunity of asking questions. The debate, which was very full and free, occupied two entire days, elicited the views of many of the members, and was of great value to the committee in improving what had been presented.

The report, as worked over by the committee, with the addition of its Rules for the Movement of Trains by Telegraphic Orders, was again presented at the April, 1887, meeting, where it was again discussed in a session lasting two days, and finally adopted April 14, 1887, 49 roads voting for and five voting against its adoption.

Following the general notice were 11 general rules—seven covering standard time and four timetables, 56 signal rules, 43 train rules, and 27 rules of telegraphic orders, or 137 in all, together with eight forms of train orders and four blank forms.

The committee took the report in hand for the consideration of arrangements for publication, and after a wide correspondence and six days of discussion, submitted the matter to the meeting of the Convention of October 12, 1887, whereupon, after a full day's debate, resulting in changes in three rules, the final report of the committee was adopted, there being two votes in the negative, and the committee, after three years of devoted attention to their arduous task, was discharged.

Perhaps the greatest change made by the Standard Code was the substitution for the "Single Order" System in telegraphic orders of the "Duplicate" or "Double-Order" System, the use of which had been steadily gaining ground. In giving effect to other changes the code did little more than embody the best recognized practice. It is hard from this distance of time to estimate the enormous value of the code in its orderly arrangement, its conciseness and clarity of language and its bringing under one standard of practice all

the roads of the country. The preparation of the code drew freely upon the time and brains of men already burdened with responsibilities of no ordinary character.

At the next meeting of the General Time Convention there was created a "Standing Committee on Train Rules." As the several roads put the Standard Code into effect more or less expression was given to the individuality of their officers, and while comparatively little or no change was made in the principles as laid down, there was considerable discrepancy in the language and formulation of substitutes where adopted. While the number of changes might have been of slight importance on any one line, they were greatly multiplied when a number of lines were considered, and led to confusion tending to defeat an essential object in the adoption of the code.

The committee had further not been so successful as they had hoped in the clarity of their language and in the application of the rules to the very wide differences of conditions and practice. They considered from time to time improvements in the code and changes, not many, but important, were made in the meetings of April 10, 1889, April 8, 1891, and October 12, 1892.

The practice also arose of a formal interpretation by the committee of the rules in answer to inquiries submitted to it. The committee sought to define in the sense in which it was used every word capable of more than one meaning, and urged that the men should so familiarize themselves with the language of the rules as to be capable of repeating them from memory. These inquiries and the adoption of several amendments by the Train Dispatchers Association in October, 1891, led the committee to announce at the meeting of April 12, 1893, that it would during the next two years undertake a thorough revision of the Standard Code of Rules divided on a general plan of rules for single and double track service; three or more tracks, block system and interlocking.

The committee held meetings covering 13 days and submitted for adoption its report at the meeting of April 17, 1895. After a spirited debate covering the sessions of two days, the report of the committee as a whole was adopted.

This action did not, however, cover the movement of trains on telegraph orders, the report of the committee on this matter being submitted to the meeting of October 17, 1895, discussed and adopted.

The committee sent the code which it had prepared to all the members for criticism in a circular issued October 20, 1893. They considered the many replies received thereto in sessions lasting 11 days, and submitted their report for discussion to the meeting of the convention of March 12, 1894. They had suggested some 33 changes, mainly to prevent misinterpretation of language, but making a material change in the flagging rule, No. 99. A number of rules were eliminated as belonging to other regulations of the service. The discussion invited by the committee consumed the entire day and the report was recommitted.

In April, 1898, the association in a further effort to clarify the Standard Code of Train Rules had directed the committee to review it for the purpose of classifying the rules and indicating which were exclusively applicable to single-track service, to double-track service and to both single- and double-track service. At the meeting on October 12–13, 1898, the committee submitted their report, stating that they had devoted 33 days to their task. A series of definitions had been prepared, made necessary by difficulties arising in the application of the code to the requirements of the service throughout the country, and the numerous and pertinent questions raised as to the meaning of many of the rules. The code was rearranged and developed in a more logical sequence, and as presented was believed to be consistent with the principles upon which it was founded and to contain a simple and concise expression of the essential requirements of a practical set of rules for the operation of a single track railroad.

Early in my service with the Pennsylvania Lines I had gone one night into the general manager's business car to find him discussing signals and train rules with the division superintendent and trainmaster. "A light locomotive just went by here running south in the back-up motion. What

signals should it have carried and where?" asked McCrea of me. Well, I was an assistant engineer and thought I had gone in to "clear," when I replied that I didn't know a thing about it; but I was promptly advised that after Sunday morning devotions I would do well to put in the rest of the day studying the book of rules. There have always been some suggestions that I have been willing to take literally, and this was one. Fortunately, too, the trainmaster was a competent man, amiable and very ready to be of help, and about the time I began to comprehend the matter the Wabash Railway took running rights over one of our divisions, and I first assisted him in examining their crews and later went up to Peru, their division headquarters, to examine those that could not otherwise be conveniently reached. It was a splendid experience, fixing the matter definitely in my mind and showing clearly the vital importance of the subject. Subsequently, during six years as division superintendent, the code was a tool of familiar every day use. I had with me as trainmaster, Louis Ohliger, whose familiarity with the actual movements on the road, the rules and their application equaled that of any one I have known and whose attitude of mind was the most "judicial" of any with which I have been brought in contact. I profited much by my association with him. When as general manager of the Pennsylvania Lines West, I began in April, 1896, to represent that company in the American Railway Association, I was fully alive to the importance of the subject, its merits and defects and the responsibilities attached thereto.

When the rules came up for final action, I prepared myself carefully on all the moot points, holding several meetings with my officers, resolved to contest nothing but things of prime importance, but to make every effort to secure their correct setting out. I was greatly impressed with the value of the work done by the committee. What the committee sought to do was not to bring in any new principles, but to express in better order, in better arrangement and in more concise and clearer language the practice as it existed on the best managed single-track lines. It had not occurred to

me that it would be possible so to digest, rearrange and clarify the code as the committee had done, and I regarded it as one of the most valuable improvements with which the Association had had to deal. I believed the distinction which the committee had made of single-track operation would do more to relieve the larger roads of the difficulties which they had encountered by being tied up with the single-track lines than anything which had been suggested.

But the rules when adopted had to be given practical effect: they were to be put into the hands of brakemen and firemen as a text book in which they might learn their business; these men would have to be examined for promotion as conductors and engineers; the rules were to go into the hands of the men who had to do with the practical operation of the road. No effort should, then, be spared to make them in every way the very best procurable. Holding these views, I took a very active part in the debate and pressed the matter to a point where the committee took their report under further advisement, the first time in the history of the association where a committee failed of the support of the floor. The confidence given me on that occasion led to my election as president of the American Railway Association at the spring convention. It was an honor I very much appreciated. It gave me a very wide acquaintance with the operating officers of that day and compelled a systematic consideration on my part of almost all the active questions of railroad operation. It also afforded an opportunity to go to the Paris Exposition in the summer of 1900, to meet there the active railroad officers from all the countries of the world, and, as head of a committee, to present an invitation, which was accepted, to the International Railway Congress to hold its meeting in 1905 in the City of Washington. This has been the only meeting of the Congress in the United States.

The work was, however, very arduous, absorbing about 48 days of the year in committee and convention work beside much time in correspondence, and I felt I could not in justice to my company long hold the office. On these grounds I therefore declined to let my name be brought forward as a

candidate at the end of two years' service, and the practice has since been followed of short tours of duty in that office.

The report on the Standard Code came up for final consideration and was adopted at the meeting of April 12, 1899, the committee having meantime sat for nine days and having had before it many operating officers.

At the meeting of October 23, 1901, the committee presented for discussion a Code of Train Rules for double track. This code involved a recognition of the following practices:

(*a*) The movement of trains with the current of traffic by the substitution of signals for time-table superiority and train order right.

This is for the purpose of facilitating the movement of trains with the current of traffic, and thereby enlarging the capacity of the two tracks.

(*b*) The movement of trains against the current of traffic by train orders.
(*c*) The movement of trains against the current of traffic by signals.

Both (*b*) and (*c*) are for the purpose of facilitating the movement of trains to a still greater extent by utilizing the facilities of both tracks.

After discussion, the proposed code of rules for double track, when operated in the normal direction of the traffic, was referred to the committee with request to formulate rules under the method of practice that it had suggested. The committee, having spent six days in the further consideration of its report, presented it for adoption at the meeting of April 23-24, 1902. The code after full discussion was adopted with some changes in the single track rules to bring the two codes into harmony.

On April 5, 1905, the committee submitted rules for the operation of trains on three and four tracks, which after discussion were adopted.

The committee had now, after 19 years of work, pretty well covered the entire ground committed to it. It had

brought forward and secured the adoption of its code for operation on single track, April 14, 1887; on double track April 24, 1902; on three and four tracks, April 5, 1905, having meanwhile, in connection with the Committee on Safety Appliances, secured the adoption of rules for governing the movement of trains with and against the current of traffic on double track by means of block signals, October 28, 1903. It had answered by correspondence many questions regarding the rules and the practice thereunder, and by the discussions of its reports from convention to convention had educated the higher officers to the varying conditions in different parts of the country and to the problems and views of their associates. Thereafter the work of the committee was confined largely to the answering of inquiries and an occasional revision of the rules as the state of the art advanced. On April 25, 1906, the American Railway Association approved a report of the committee making a general revision of the code for single and double track.

The committee began in October, 1911, a general revision of the entire standard code of train rules for single and double track, rules governing the movement of trains with the current of traffic on two or more tracks by means of block signals, rules governing the movement of trains against the current of traffic on two or more tracks by means of block signals, and additional rules for three or more tracks. This report was adopted at the Convention of November 17, 1915.

It is impossible to overemphasize the importance of the standard code in governing the movement of trains. There is little if any want of perfection in these rules to prevent accidents. Rarely, if ever, would accidents occur if these rules were obeyed, and accidents will be reduced to the extent to which the rules are properly enforced and obeyed. Too much time and attention cannot be given to the teaching and training of the men in their use. It is the practice to give such instruction individually, and on the larger lines to have an officer devote practically his whole time to that end. Where the investigation of an accident discloses any incapacity, the delinquent should be required to study the rules during the

period of suspension and not be returned to service without adequate examination.

I have reviewed this history at some length because there is a general tendency to take for granted the things with which we have always been familiar, and because I think it of great importance to know that the standard code did not spring full panoplied from the head of Jove nor grow like Topsy, but developed out of the experience and thought of those who had preceded us and to whom we are under great obligations; obligations that call upon us to transmit unimpaired and in their full vigor the things that we have received and to make to them the additions of which we are capable.

The time-card, or schedule, is for the purpose of giving definite information as to the movement of trains; it says, in effect, that no train shall pass any station before the time designated in its tabulation. There are more trains to be moved than can be put on the time-card, and some provision has to be made to run more than one train on one schedule; that is, under the same number. This is done by calling them "sections," as, first, second, etc., in the order in which they proceed. In running a train in sections, or convoys, each must be notified of its position, and the sections are treated not as parts of the same train, but as individuals, each having the same authority to use the track as if it were the only one, with the single exception that they may not change their position in the convoy. In order that all parties may know that there is more than one section under any number, flags are displayed on the engine of each section excepting the last; a section without these signals is the last of that number and the train is done for that day.

For the prompt movement of freight not provided for by the time-card, and for the movement of work-trains using the track in both directions, trains are authorized to use the main track by train orders. Many serious accidents, caused by errors in train-dispatching, have occurred in the movement of extra trains. In the early days such movements were studiously avoided. I recall one Division Superintendent who made it a rule never to go to bed when an extra train was on

his line. Later this movement became common practice. Great precautions must be exercised in running two extras toward each other on single track, and in running an extra through work-train limits. Positive instructions must be given to all concerned as to precisely where they are to meet or pass.

On roads having double track for their full length, men sometimes fall into the habit of considering only the trains using the same track as themselves and neglect the trains on the opposite track, with which they are extremely unlikely to have any dealings; and in case of wreck, wash-outs, or other interruption, if single-track operation becomes necessary, they are consequently often much at sea. The English make these movements by putting them in charge of a pilot, dressed in a red jacket, and no train is allowed to move on the single track, unless the pilot is on the engine. The best way to move trains through a gauntlet of this kind is to extend it between two telegraph stations, prohibit the operators allowing any trains to enter without orders, and direct the dispatcher to move all the trains by absolute orders. The use of the telegraph (or telephone) or the block signal system for the conduct of the trains under these varying circumstances is now universal. The whole system of train running is based on the ability of men in charge of trains to see and know every other train which can affect their movements, and at ordinary junction points, where the traffic is light, registers are introduced, upon which conductors register the arrival and departure of their trains, enabling those in charge of trains arriving at that point on the branch line to ascertain which trains have passed on the main line, or *vice versa.*

The "Single Order" system consists in sending an order to one train, stating what to expect from another, and by a separate order instructing the second how to proceed against the first. As each train is mentioned only in the address of one and in the body of the other order, and as there is no similarity in the language used, there is great danger that some point may be overlooked, and this is greatly increased when the movements are complicated. Further, one operator

will frequently repeat his order for verification some time in advance of the other.

The responsibility for the movement rests almost exclusively upon the train dispatcher, who, upon a crowded road, not infrequently issues from 15 to 20 orders an hour to move the traffic.

The "Double" or "Duplicate Order" system had its inception on the Pittsburgh, Fort Wayne & Chicago Railroad about the year 1859, and has since been established with slight alterations or changes, upon all the leading lines of the country. It consists in sending to all trains involved in any movement the same order in the same words and at the same time, and operators repeating their copies, underlining each word on the office copy as it is transmitted over the wire. It is best that an order should not include more than two trains and one movement. When this cannot be done the trainmen should receive these instructions on one sheet, with the movements against opposing trains arranged in the order in which they are to be made.

The most important point in the whole system of train dispatching is that orders shall be understood. The men should be so familiar with them that they are recognized on sight and are instinctively properly obeyed.

J. J. Turner, in his book published in 1885 entitled "The Telegraph as Applied to Train Movements," laid down the following principles and safeguards:

1. That to prevent conflicting instructions and to assure safety, no more than one man can dispatch trains on the same track at the same time.
2. That the dispatchers be kept fully advised of all delays, present or prospective, and the position of every train on the road. This is insured by reports from telegraph stations and persons in charge of terminals.
3. That orders must be so clearly expressed as to render a misunderstanding of their meaning impossible. Forms are adopted which are used whenever practicable and which become familiar. Erasures and alterations are prohibited.
4. That the dispatcher must know that the orders are in the hands of some reliable person for delivery. He insures this

by the acknowledgment of the operator who gives his own initials and his office call.

5. That it is as near certain as anything human can be that the person who is to deliver the orders will stop the train to which they are addressed. Fixed signals are a part of the apparatus of the operator's office, normally at danger, to stop all trains unless intelligently manipulated.
6. That when delivered to trainmen they read just as they did when sent by the dispatcher. The receiving operator repeats the completed order to the dispatcher for verification.
7. That the instructions given to both trains are identical, insured by the double or duplicate order system.
8. That the train whose rights are extended must not be moved against the train whose rights are curtailed, without notice to the latter. Orders are sent to both trains at the same time.
9. That men who are to act upon orders acknowledge their receipt. The signatures of the conductor and engineer are required and secured before the orders are delivered to them.
10. That men using the orders know that they are doing so with the full knowledge and authority of the dispatcher. On each order, after the signatures have been sent to the dispatcher, the operator inscribes the response "Correct."
11. That trains running against other trains under special orders must be able to recognize each other. The number of the engine on every train mentioned in the order is given.
12. That a complete record be kept of each transaction. In the dispatcher's office is kept an order book, in which all orders are written and upon which each subsequent step is recorded.

200.—Block System and Interlocking Signals.—Signals of a kind are known to have been used three centuries before Christ, and concerted signals by the display of shields were used to control the movement of troops at the Battle of Marathon. As means of conveying information and command they were worked out in great detail in marine and army operations. In railroad practice the fixed signals were usually discs or semaphores, with lights permanently fixed (on posts) at the side of the tracks or on bridges over the same.

These fixed signals were used in two quite separate devices: (*a*) in interlockings at junctions, sidings, and yards; and (*b*)

in block signal systems for maintaining a space interval between trains following one another as a substitute for the time interval that was relied upon in the early days of railroading.

As early as 1846, it had become a common practice in England to concentrate the levers for throwing switches and signals in a cabin, and the necessity for interlocking these levers to make certain that conflicting routes were not set up for use became evident, and soon was considered essential to the rapid movement of the trains and the economical use of the tracks.

About scales, and in other yard locations not involving main track movements, I have never hesitated to cluster the levers for a number of switches in a single frame without interlocking, and the practice is safe and should have a more extended vogue. Many of the interlockings of to-day, as at the beginning, are worked by a system of rods or cables. In the larger ones covering an extended area, low pressure pneumatic power was used, but this has (since 1900) been almost universally supplanted by electrical devices.

Not only is security and speed in handling the switches obtained by their use but at grade crossings and drawbridges interlocking signals with derailing devices obviate the necessity of stopping trains, and saving the stop saves both time and money.

In 1885, what is now the Chicago Great Western Railroad was building into Chicago, and their arrangement for crossing the Pan Handle contemplated at their expense the erection and operation by the latter company of an interlocking. The work was under my supervision. At that time, the Lake Shore, Chicago and Northwestern, Chicago, Milwaukee and St. Paul, and many other lines, ran the left-hand track in their double track sections. The Pan Handle owned a stretch of double track at this point that was used by the Chicago, Milwaukee and St. Paul under a disputed claim of ordinance rights. I felt that if the running rights here were to be brought into harmony with the rest of the Pennsylvania Lines, the change should then be made. I talked it over with the

superintendent, who did not care to do anything but had no objection to my taking it up with the general manager. That officer did not consider it wise to precipitate a controversy with his tenant, but had no objection to my trying what I could do.

In due time I posted notices that the interlocking would be cut in at noon on a certain Sunday, and that from that time on trains would run normally on the right hand track. Having no official position that would give my instructions any great weight, I followed the English practice of issuing the notice "by order." No questions were raised by the Milwaukee and everything went off like clockwork. Many years after I sat next A. J. Earling, then president of the Milwaukee, at dinner, and, recalling the incident, asked what their views had been. He said that, when the notice was posted with its unusual signature, they discussed the matter at length and concluded that we had a thought-out plan of contesting their claims and that since it was only a question of time when all American roads would run to the right, they might as well make the change and avoid their hand being forced.

The action of the General Time Convention was perhaps influenced by the passage by the English Parliament in 1889, of an act requiring their railways (1) to adopt upon all passenger lines the "block" system of working; (2) to interlock their points (switches) and signals; and (3) to fit all trains carrying passengers with some form of automatic continuous brake.

As early as 1842, W. F. Cooke devised a manual block, using a single-needle instrument giving two indications. In my boyhood the Pennsylvania Railroad was using a system of bell taps by which the operators at either end of the block signaled the entrance and departure of trains in the block. By 1872 block signaling began to be generally used in England, and, to overcome the danger arising from carelessness or forgetfulness on the part of operators, W. R. Sykes, about 1876, developed a device for "locking" the mechanical signals by breaking the electric circuit. Valuable improvements were made by Patenall, and others, and this system, known as the

"controlled block," was for a time largely used in this country.

Signals worked by the trains themselves, and without human intervention, seemed so much more attractive that with the rapid development of the electrical working this practice, known as the "automatic block," soon usurped the field. The changes took place with great rapidity. The disc signals gave place to the semaphore; I devised an upper quadrant indication that drove out the signals working in the lower quadrant; the illuminated blade was tried and abandoned, and now an arrangement of lamps to indicate a beam of light in the several positions has many supporters. The position of normal safety has given place to the normal danger, while double block indications are given on some high speed lines; and though it modifies the essential principle, the necessity of permissive blocking is frequently yielded to in bunching the trains approaching terminals or to increase the capacity of tracks under special conditions.

On single tracks the signals in one direction (say eastbound) are actuated by current conducted by the rails; in the opposite (say westbound) by a current conducted by means of a line strung on poles. The train in a "block" sets the signals two "blocks" away so as to provide against the simultaneous entry of two trains.

The fundamental principles of railroad signaling are simple, but the development of the science has called for much study and a great money outlay. The problems of safety, economy and convenience react upon one another and make each problem individual and incapable of a perfect solution. The questions are, in their last analysis, relative, and give a fine chance for the display of judgment.

At the General Time Convention of October 9, 1889, the Executive Committee brought in a report recommending that "as various devices are being presented to railroad managers for their consideration, such as power brakes, automatic car couplers, interlocking switches, block systems, and for heating and lighting cars, it is important that data be collected from which conclusions may be arrived at as to the best forms for

general adoption; a committee be appointed by the president to be known as the 'Committee on Safety Appliances' to consider what are the essential requisites in all devices for power brakes, automatic car couplers, interlocking switches, block systems, and for heating and lighting cars, and what action should be taken by the convention with reference thereto."

The committee in time studied and reported upon the prevailing practice in car coupling, train heating, train lighting and power brakes. At the Convention of April 13, 1892, it reported that in regard to the subjects of interlocking switches and block signals, it would further take up these subjects in conjunction with the Committee on Train Rules. This work was thereafter undertaken by what was known as the "Joint Committee on Interlocking and Block Signals." The task of the committee was difficult and useful. It sought all the light that could be thrown upon its labors by addressing letters to the members of the association, and by having before it the signal engineers of the railroads and the officers of the manufacturing companies. It traveled a great deal and took the opinions of the men who worked this peculiar apparatus to find out from them what their difficulties were, and investigated foreign practice, particularly that of the English railroads.

The committee brought in its first report at the meeting of April 12, 1893, confined to the suggestion of some preliminary definitions and the presentation of information which fairly represented the best block signal practice of the day, in its several forms of telegraph, controlled manual and automatic block systems. The suggestions of the committee were brought forward tentatively from time to time and very fully debated. A report was submitted on April 11 and 12, 1894, and the committee was asked to formulate a set of rules that should be applicable to any set of block signals, whether telegraphic, automatic or controlled manual, etc.

Reports were submitted for discussion on October 17, 1894, and April 17, 1895. In the report of October 16, 1895, the committee indicated for the first time the full scope of its work, and the sequence in which it thought best to arrange the

definitions, the requisites of installation and the rules for the different block signal systems. It submitted its final report on this branch of its work to the convention on April 15, 1896, when it was adopted.

A report on interlocking was presented on April 7, 1897, suggesting the interlocking of signals with switches, locks, railroad crossings, or drawbridges, so that a clear signal cannot be given unless the route to be used is clear and stop signals displayed for all conflicting routes, and offering as a definition of interlocking, "levers or their equivalent, located at a common point, by which switches, locks and signals are operated in a predetermined order, and through which switches, locks, railroad crossings, drawbridges and signals are interlocked." A report was submitted at the meeting of October 6, 1897, and the definitions and requisites for interlocking were adopted.

On April 7, 1897, the Committee on Safety Appliances, which had been in joint session with the Joint Committee on Interlocking and Block Signals, presented a series of definitions and requisites for installation of interlockings for discussion and at the subsequent meeting of October 7, 1897, the Joint Committee presented this matter as their final recommendation and it was adopted. At the Convention of April 25, 1900, a revision of the block signal rules was adopted and on October 24, 1900, a revision of the rules for the operation and maintenance of interlocking plants, and finally on November 18, 1908, it was reported "the substitution of the telephone for the telegraph in blocking and dispatching trains can be made safely, and the use of the telephone for such purposes is recognized and recommended as a standard operating instrumentality, and this report adopted."

Some minor changes embracing features that had been developed by experience with the code were made at the meeting of May 19, 1909. The code was again revised and the revisions adopted at the meeting on November 17, 1915, valuable assistance having been given in its revision by a committee of signal engineers, members of the Railway Signal Association. The committee used great care in providing such latitude as had proved safe in practice, without restricting all

the railroads to one rigid system of signal practice, believing that the best results would be obtained by freedom of trial and future experience, and contenting itself with stating the general principles that it was felt would sufficiently point to the course to be pursued in order to arrive at the best method of operation in varying circumstances and to secure such uniformity as might be had in practice.

The committee encountered great difficulty in the effort arising from the difficulty of obtaining three different colored lights for the night indications, of danger, caution and safety. Red and green could be given in strong lights, but the kerosene lamp upon which, in 1894, it was necessary to depend, gave a light composed almost entirely of red and green rays, the combination producing yellow. The blue rays were few, and the light feeble and indistinct when passed through a blue glass. Experiments were made with amber or yellow, but without satisfactory results, though later a lens was produced by the manufacturers that enabled the use of this light, and the use of green as a caution signal was definitely abandoned on April 11, 1894. It was no easy task to harmonize apparently conflicting views or to prescribe that which, losing sight of no essential safety, nevertheless admitted of general adoption without doing violence to existing systems. On the whole, the report, considering the rapidly developing state of the art, was a particularly difficult piece of work and, although it had taken a long time in its preparation, was one of great usefulness.

There is another aspect of this question to which thought may well be given. For many years continued charges and accusations were made that railroad officers refused to investigate new and valuable inventions, and that signal companies belittled them, bought them up cheaply and suppressed them. This clamor finally resulted in Congressional legislation and a Block Signal and Train Control Board was created, under the jurisdiction of the Interstate Commerce Commission, to examine the matter. From their first Annual Report, dated November 20, 1908, we find the board reported that "inventors often are exceedingly persistent, and some of them sorely dis-

appointed at the unfavorable decision returned again and again." The board was competent and dispassionate, painstaking and judicial, and after a year's work found nothing fo recommend. The board examined 371 devices; found only 12 of enough merit to warrant even an inquiry; and of these only 4 were in the hands of proprietors who had the knowledge and energy to install their apparatus, and only one was ready for a test.

The principles involved in every device submitted were found to be either:

1. Of a class already well known, which had been examined by many practical railroad men and virtually rejected as not promising any substantial improvement in the safety of railroad traveling generally; or

2. Those embodying "wireless" or other undeveloped schemes which, while very interesting from a mechanical or electrical standpoint, did not offer any practical advantage over the simple devices already in use in connection with automatic block signaling on all our principal railroads, or over plans already well enough known but known to be useless.

This effectually tells the whole story with which railroad officers have long been familiar. It was a "water haul" catching no fish, but the lesson to inventors who spend money and time in attempting to improve arts with which they have no practical acquaintance was not altogether ineffective. It is much to be regretted that similar means cannot be found to quiet other outrageous slanders.

201. Planes.—The early operation on the Delaware and Hudson Company's railroad between Carbondale and Honesdale was by a series of inclined planes. This necessitated two tracks somewhat widely separated in order to secure a suitable location. The cars were hauled up the ascending planes by cables, at first of hemp and later of steel. The total lift from Carbondale to the summit at Farview was 872 feet and was overcome by 8 planes of from 1257 to 1479 feet in length, varying in grade from 7.18 feet to 10.05 feet per 100 feet. From the summit at Farview the descent to Honesdale was 962 feet, being accomplished on four descending planes of

from 1322 feet to 1463 feet in length, having grades of from 8.18 feet to 8.84 feet per 100 feet. In the reverse direction the empties were lifted between Honesdale and the summit at Farview by eight ascending planes of from 629 feet to 2630 feet in length, having grades of from 8.29 feet to 19.74 feet per 100 feet.

On the loaded car track between these ascending planes were so-called levels, having a slight grade for drifting cars to the foot of the next plane. After the cars reached the summit they were lowered down the four descending planes by cable and from the foot of the last descending plane drifted in to Honesdale by gravity, a distance of about 10 miles, on a descending grade of about 44 feet per mile. On the empty car track between Honesdale and Carbondale the empties were handled in a manner similar to handling the loaded cars, the longest drifting level being about 11.25 miles, having an average grade of 72½ feet per mile.

The cars were handled on the descending planes by means of cables, their descent being retarded by a braking mechanism consisting of a large wooden fan, which revolved through the pull of the cable over the sheave wheel at the top, the air resistance generally furnishing sufficient retarding force. This retarding fan was further controlled by an operator by means of a hand brake, which was applied at times when excessive speed required such additional braking.

On the drifting levels the braking power was obtained by brakes applied by hand on generally every third or fourth car. The train, consisting of as many as 70 cars, was in charge of two or three brakemen, each of whom, after applying the brakes, dropped to the ground, mounted the next car equipped with brakes, set them and repeated the process until the train was brought under control. In cases of emergency, descending cars could be stopped by the use of a "sprag" or heavy wooden stick, which was thrust against lugs cast on the outside of the wheels engaging the top beam of the truck, causing the wheels to slide. The application of a sprag was a difficult maneuver, requiring extreme skill in throwing the sprag into the wheel at the proper moment to engage the truck beam.

The cars were small eight-wheel gondola type carrying about five tons, the winding drums having a capacity of about five loads up the plane or ten empties. The heaviest movement in one day is reported to have been 2000 loaded cars, or 10,000 tons of coal.

In addition to coal, this gravity railroad was also used for handling miscellaneous freight in small box cars. Passenger service was established in 1859 along the Lackawanna River, between Carbondale and Olyphant. Regular passenger business over the mountain between Carbondale and Honesdale was instituted by the middle 70's and was continued until the gravity road was abandoned, and it is a matter of great pride to be able to state that during its entire period of operation in the passenger business, no passenger was ever killed through the operation of the gravity road. The service, both for passengers and for coal and other freight was maintained until February, 1899, when a single steam operated line was built, utilizing 50 per cent of the original location, and the use of the planes was abandoned.

The operation involved a high degree of activity and skill and is recalled with great pride by all who were engaged in it. As a matter of fact, on the D. and H. an operating man who was not brought up on the "Gravity" is looked upon rather doubtfully as to his transportation ability.

This method of operation was, for a time, in quite general use in the anthracite region, but to-day it is in service in but two places.

The "Mahanoy Plane" of the Philadelphia and Reading Railroad, 2440 feet in length, overcoming an ascent of 354 feet by a grade of 17.99 per cent, is a "balanced plane," being double-tracked, the descending empties by their weight assisting the power supplied to the winding drum to pull up the loads. This plane handles 20 to 25 trips per hour, the cable being attached to a "Barney" engaging the gondolas from the rear. The maximum number of loads that has been handled in 24 hours is 647, and the average number of loads is about 583.

The "Ashley Planes" of the Central Railroad Company of New Jersey, operating from Ashley to the summit of the

mountain near Solomon's Gap, in the vicinity of Wilkes-Barre, Pa., are in three flights, No. 1, 3700 feet long, with 9.28 per cent grade; No. 2, 3000 feet long, with 14.65 per cent grade; and No. 3, 5000 feet long, with 5.7 per cent grade; total length between receiving and delivering tracks three and a quarter miles; total ascent 1014 feet. A maximum of 60 loads per hour can be handled up the three planes, the average rate during operation being about 45. The planes are not constantly in operation during the entire year, nor during the entire 24 hours of a day, but to furnish some idea of the efficiency of the plant the following figures will be of some interest:

Number of days worked................	305
Coal tonnage hauled.....................	4,827,104 tons
Coal tonnage and weight of car..........	6,832,935 tons
Merchandise, tonnage hauled............	974,800 tons
Coal, car and merchandise tonnage hauled in one year...........................	7,807,735 tons

The empty movement and the movement of passenger trains is made by locomotives over the main line. When the planes are not in operation the loads are moved over the main tracks of the railroad, 12.5 miles, with a ruling grade of 1.8 per cent and the same total ascent, 1014 feet. This permits a comparison of these contrasting systems of working, both as to capacity and cost. To move over the main line with locomotives the tonnage handled up the "Ashley Planes" would require daily the use of from 18 to 21 locomotives of approximately 45,000 pounds tractive power each, at an operating cost of from two and one-half to three times the present cost of operating the planes.

It would seem that the plane offers an economic resource in railroad practice not now much availed of, and might well receive careful consideration in locations involving expensive construction and costly working. In overcoming considerable ascents the power used in lifting the locomotive itself is very expensive. Against this in the plane there is only the weight of the cable and the barney. Further, the use of the balanced plane affords an additional economy, and where the loads

descend might be practicable to substitute gravity for other power for the entire work demanded.

202. Economic Waste.—Among influences that have affected the construction of tariffs in the past have been the recognition of the great distances over which the commodities must be moved, the development of a new country which was being opened up for settlement, the effect of further competition and the weight given to the principle of the "additional ton"; that is, to the feeling that to add new business a road is warranted in imposing any rate that is above bare cost, the profits of which, however, small, would contribute to support the "overhead" and unavoidable expenses.

It is upon this theory that the "Southeastern basing-point system," the "Texas common-point system," the New England "blanket" or "postage-stamp" system, and other methods are founded with the effect of producing equality of rates, irrespective of distance; that is, "a rate that the traffic will bear," or perhaps better expressed as "a rate that will stimulate the traffic," and it is upon this principle that tariffs have been issued upon which something like three-fourths of the tonnage is now moved.

This system extended markets, enlarged the field of competition, equalized prices over large areas, opened up new channels of business, lowered cost production, made possible the rapid opening and settlement of new territory, and maintained the prosperity of territory otherwise isolated as, for example, the New England States.

The energy, resource, adaptability and ambition of traffic officers, business men and communities were alike stimulated and encouraged and American commerce was distinguished by its freedom from restraints. To a very large extent the railroads made the business and it would be hard to overestimate their contribution to progress. It was, however, affected with two outstanding features that were alleged to be great abuses. The circuitous haul, or the combination of the long and back haul, was often as much as 50 to 60 per cent longer than the short route, and there were many concessions to individual shippers, usually in the form of rebates.

In Germany freight is not allowed to be routed over lines longer by more than 10 per cent than the direct route and the United States Railroad Administration undertook in some districts to restrict it to, in some cases, 15 per cent, and in others 30 per cent. American railroads attempted to control the abuse of circuitous routes by pooling and by division of territory; the large industrial corporations by strategic location of plants and by bare-price schemes—that is, prices with freight added—while Congress enacted the Long and Short Haul clause. Professor Ripley, writing in 1907, condemns the rate-making practices which have been described as inordinately swelling the volume of ton-mileage, diluting the ton-mile revenue, producing rigidity of industrial conditions, stimulating centralization both of population and of industry, and a tax upon American production. He ascribes the economic wastes to congestion of the direct route, rate cutting by the weak circuitous line, abuse of prorating practices in division of joint through rates, desire for back loading of cars, strategic considerations concerning interchange of traffic with connections, and attempts to secure or hold shippers in contested markets.

Some of these sources of waste are now dried up. The argument on the circuitous haul takes distance only into consideration and ignores the effect of grades, facilities, locomotive power and efficiency of operation and management, which are in themselves sufficient in numerous cases to overcome even the most conspicuous of the differences he mentions.

In the spring of 1917 under the operations of the director general a study of the conditions in the Western Traffic Region was made with a view to re-zoning the traffic, eliminating all lines where the distance involved a haul of more than 10 per cent in excess of the short line. The considerations stated led to the abandonment of the project. It was recognized by the railroads and traders alike that circuitous hauls so far as they existed were amply justified.

The transportation officer will look for the effect of the practice, where it exists, in his costs and "transportation ratio," and the country, to the extent that it is abolished, to

the effect upon its relative prosperity and contentment in the next generation.

Think on George Stephenson, his beginnings in poverty, his struggles for an education, his triumphs over difficulties! Think of him going after the job on the Stockton and Darlington Railway! With Nicholas Wood, he started from Killington and rode six miles, then went in a coach 30 miles to Stockton, then walked 12 miles through the fields over the line of the proposed railway, then had an interview with Edward Pease, the projector of the road, then walked on the return journey 18 miles from Darlington to Durham. What the "eight hour clock-watcher" might call a full day's work.

PART VII

MEN—FIRST SECTION

To each according to his need.

SOCIALIST DOGMA.

To every man according to his several ability.

ST. MATTHEW, 25-14.

PART VII

MEN—FIRST SECTION

203. General Rules Governing Employees, Operating Department.—At a meeting of the American Railway Association on October 11, 1893, it was:

> RESOLVED, That a special committee of nine members be appointed by the president to obtain the rules and regulations at present in use by the several members of this Association defining the duties of enginemen, firemen, switchmen, trainmen and telegraph operators, to prepare an abstract of same so classified as to exhibit their points of general agreement or variation, and to report upon the subject at the next meeting of the Association, with such recommendations as may be deemed advisable.

The first meeting of the committee was held on February 7, 1894. A report was submitted at a meeting on October 17, 1894, for the general information of the association and for the purpose of eliciting criticisms and suggestions, covering a set of rules for enginemen, firemen, conductors (both passenger and freight), baggagemasters, brakemen (both passenger and freight) and switchmen. The committee held further meetings on May 28, August 28, October 15 and December 10, 11, and 12, 1895, and February 25, 1896, and again submitted a form of report with an earnest request for criticisms and suggestions of amendments or additions.

The committee held further meetings on May 26 and August 19 and 20, 1896, and submitted its report for adoption at a meeting on October 7, 1896. After discussion it appeared that some of the questions involved affected the work in charge

of the committee on train rules and the committee on safety appliances, and arrangements were made to have the three committees jointly give consideration to the subject.

The rules were classified as follows:

General Rules	22
Trainmen	5
Passenger trainmen	6
Passenger baggagemasters	3
Freight trainmen	5
Engineers and firemen	12
Telegraph operators	15
Total	68

At the meeting on April 7, 1897, the Conference Committee, being the three committees to which the subject had been referred, submitted a report. It had held sessions on December 7, 8 and 10, 1896, February 2, 3, 4, and March 9, 1897. The Conference Committee had added a general notice of four paragraphs and clarified some of the rules. The report, after debate, was adopted.

204. General Rules Governing the Determination of Physical Qualifications of Employees, Operating Department. —At a meeting of the American Railway Association on October 23, 1901, the Committee on Safety Appliances reported that, at the recommendation of the Executive Committee, it had begun the investigation of the practice on the different roads with reference to tests for color perception, vision, etc., and that a circular requesting information from the various roads would soon be issued. The practice was originally inaugurated in 1884 on the Pennsylvania Railroad and had gradually been very generally adopted.

The committee reported progress at a meeting on April 23–24, 1902, and requested definite instructions from the association, whereupon the following resolution was adopted:

> RESOLVED, That the Committee on Safety Appliances, in the light of the information which has been presented, and such further information as it may deem necessary to secure, is instructed to proceed with the formulating

of rules and requirements which it may recommend for employees in and applicants for railway service as to their educational and physical qualifications, and the examinations requisite therefor, and to report to the association.

The committee made further progress reports at meetings held on October 22, 1902, April 22 and October 28, 1903, and April 27, 1904. On October 26, 1904, it presented its report, stating that the American Academy of Railway Surgeons had coöperated with it with reference to the subject of physical examination and that valuable information had also been obtained from the American Ophthalmological Society, prominent railway surgeons and experts, and from other sources. Various suggestions were made regarding certain rules and the report was referred to the committee for further consideration.

The committee's final report was presented on April 5, 1905, and adopted. It contained 15 rules covering eyesight and hearing tests, other physical examination, and educational examination, outlining in considerable detail the manner of making the examinations and the requirements to be met therein. They are designed to test accuracy of vision and ability to distinguish clearly the colors of prescribed signals; ability to hear distinctly; strength for the performance of the duties of a position; generally satisfactory physical condition and ability to speak without serious impediment; ability to read, write and cipher and possession of the necessary intelligence and sufficient knowledge of the language used in the rules to understand clearly their meaning.

205. The Transportation Men.—In what follows descriptive of the duties of the men, I have availed myself freely of information from:

The Train Wire....................................Anderson
Locomotive Engine Running and Management.....Sinclair
Locomotive Engine Driving.........................Reynolds
Manual for the Economical Management of Locomotives, for Locomotive Engineers and Firemen..Baker
Railway Provident Institutions in English Speaking Countries..............................Riebenach

From the reports of the Interstate Commerce Commission for the year ending December 31, 1918, the number of persons employed in freight transportation may be taken to be as shown on the following table:

FREIGHT TRANSPORTATION SERVICE [1]

	Total	Employed (but not exclusively) in Freight Transportation Service
Office clerical force	204,741	80,504
Agents (including 19,510 agent-telegraphers)	34,232	34,232
Station service employees	113,546	113,546
Train dispatchers and directors	5,403	5,403
Telegraph and block operators	44,431	44,431
The crew of the train		
Firemen	50,521	27,433
Engineers	47,699	25,901
Brakemen	88,842	48,241
Conductors	38,123	20,701
Other trainmen	3,512	1,907
	228,697	124,183
The yard crew		
Engineers	21,310	11,571
Firemen	21,979	11,935
Conductors	20,823	11,307
Brakemen	53,790	29,208
Other yardmen	89,530	48,615
	207,432	112,636
Total	838,482	514,935

[1] In arriving at the above estimate of the number of men involved in freight transportation, the office clerical force in such service was estimated on the basis of the number in service of the Delaware and Hudson Company in the Accounting Department and in the Operating Department, divided between freight transportation service and other operating department clerks, which indicates that of the entire clerical force a little less than 40 per cent are occupied in freight transportation work.

The crews of the train and the yard crews are divided on a freight and passenger train mileage basis.

If the train dispatchers and directors, telegraph and block operators, agents and station service employees were divided on the same basis, so as to give to the freight transportation service the full time of a portion only, the total number of all employees so engaged exclusively in that service would approximate 424,626 full-time men.

206. The Office Clerical Force.—The work of the clerical forces in the general and divisional offices is, in the nature of things, of a varied character. It includes handling correspondence, receiving, checking and abstracting information and reports from subordinate officers and employees; compilation of statements therefrom for the official in charge of the office where the tabulation is made or for his superiors, issue of passes, hearing and adjustments of complaints, and the thousand and one things involved in successful and efficient conduct of the business. Far too little consideration has been given to this great body of employees—chief clerks, secretaries, stenographers, typists, machine device operators, telephone switch-board operators, messengers, office boys and others. Economy in numbers has been effected through great improvements in office machinery and furniture—filing cases, loose-leaf account books, the substitution of carbon copying for the old wet impression process, calculating and tabulating machines, division and segregation of work. But faster than these devices permitted reductions in the clerical force, the growth of the business and of demands for information by government bureaus added to its number. Over a period of years it has been:

Office Clerical Force

Year	Number office clerical force	Number per \$1,000,000 gross earnings	Number per 1,000,000,000 traffic units
1890	22,239	21	199
1900	32,265	22	170
1910	76,329	27	217
1920	238,629	39	434

Similar information covering all railroad employees is as follows:

All Employees

Year	Number all employees	Number per $1,000,000 gross earnings	Number per 1,000,000,000 traffic units
1890	749,301	712	6,705
1900	1,017,653	684	5,364
1910	1,699,420	604	4,827
1920	2,031,927	329	3,693

The men forming the clerical forces occupy positions from which they may observe at leisure the conduct of operations; through their hands pass the records of movement, items of number, time and cost. They are in an advantageous position to form accurate judgment of the merits or defects of men and methods and this source of information the transportation officer would be foolish to neglect. From their ranks he should be able to recruit valuable material if he search them diligently to find the capable and ambitious. Where age has fixed their condition, or their service in a particular place forbids their transfer, suitable recognition in title, authority and pay should be accorded.

The great danger to which they are exposed is too implicit reliance on the data of reports and their failure to recognize "third factors" vitally affecting the movement but not disclosed by the condensed information shown on the reports; the cultivation of a too critical attitude upon meager information and a tendency to set and keep in motion a voluminous correspondence upon matters of relative unimportance. They should be governed by the spirit of service. The satisfaction of doing good work and receiving merited approval is far greater than is generally appreciated. Authority to use the signature of the superior should be sparingly given. On the other hand it is particularly their duty to keep the superior up to his work, to bring to his attention matters requiring disposition at his hands, to see that he is advised of appointments, of matters that must be given attention on a certain day, and

in countless ways to assist him in his burdensome tasks. Their work should be frequently checked over to correct faults which, though they may appear slight in themselves, are of a consequence that finds reflection in the expense account.

207. Station Agent.—Station agents must be familiar with all instructions, rules, methods and practices for the conduct of the business and should cultivate and maintain friendly relations with the public. They should bear in mind at all times that they are the local representatives of the company, and should be particular to see that all business with the public, whether handled by themselves or their subordinates, is transacted in a courteous manner. Coöperation with other officers of the company is essential. Determination to transact all business in the most efficient manner possible, to accord hearty and loyal support to the company, to be courteous at all times, and to give the fullest measure of coöperation to other departments and employees will bring success to the company and to the individual who thus impresses his superiors with his efficiency and desire to advance the interests of the company.

The work of the freight station and freight transfer employees is fairly well indicated by the nomenclature used in describing their positions. The clerical forces receive and record inbound waybills and issue outbound waybills, freight bills covering charges on freight shipments and bills of lading, being receipts for goods received for shipment. Their time may be taken as divided necessarily between transportation and accounting, since the waybill and subsequently the freight bill are both transportation and accounting instruments, being authority for the movement of the freight and the basis for revenue. Others keep the station accounts and render from time to time prescribed reports for the information of various officers of the company, etc., etc. I made a careful study of a typical station in 1912 in connection with some changes in the accounting system. The number of forms in use was 161, classified as follows:

TYPICAL STATION IN 1912

Department	Blanks		Total	Per cent of total
Accounting	Report	37		
	Incidental	15	52	32.3
Treasury	Report	3	3	1.9
Traffic	Report	4		
	Incidental	6	10	6.2
Transportation	Report	20		
	Incidental	52	72	44.7
Dual purpose	Trans. and traffic	3		
	Trans. and accounting	21	24	14.9

At the same time a careful analysis was made of the daily duties of the clerical force and their time was found to be occupied with the transportation department 76.2 per cent, accounting department 23.8 per cent.

Because of the large fiduciary responsibility attaching to agencies and the corresponding necessity for close and accurate accounting, there is danger that the agent may become an adjunct to the auditing and treasury departments rather than a helpful assistant to the operating officials in conducting and efficiently directing what might be termed the producing, or physical, activities of the station, attached to which are substantial returns when daily, methodically and vigorously pursued. It is worthy of serious thought whether the better plan would not be to segregate the financial features of the large agencies, supplying as assistant an accountant charged wholly with the fiduciary duties and responsibilities of the station. This would give the agent greater freedom to devote his time, thought and attention to the physical conduct of the agency, including and affording a better personal supervision of the platform work, loading and stowing of freight, and continuously following the release of equipment in bulk yards, private sidings and industry tracks.

Station agents are personally responsible for the proper conduct of the company's business at their stations. They must see that only authorized persons are allowed in ticket offices, baggage rooms and freight offices and that they are kept securely locked when unoccupied. Special attention must be given inquiries by shippers. Every effort consistent with other duties must be made to secure business. Proper information must be given patrons regarding transactions with them. They should familiarize themselves with the boundaries of the company's property and permit no encroachments thereon, and see that the station premises are in all parts in a safe and proper condition, and good order maintained. Active effort should be made to secure the prompt release and prompt placing of cars. Agents may fail to exhibit lively appreciation of the ultimate ends to be achieved by prompt loading and unloading and release of equipment by patrons, nor do they always bring to bear upon that part of their duties as much enthusiasm, energy and interest as its importance warrants. I am afraid that employees generally have not sufficiently absorbed the fact that it is the use of the car that is wanted, and not the money involved in the collection of demurrage, so that the effects of their efforts with patrons along this line have been somewhat negligible. And, in this connection, it is at least questionable whether it is sufficiently well understood that railroads have the right to unload cars and store the contents when patrons do not unload within a reasonable time. This should be stressed so that it will be fully comprehended by all officers and agents, and effectually used with patrons. On the other side, the agency has not always received the essential assistance and support of the superintendent in the way of personal coöperation in regular visits and helpful suggestions, needed force and modernized facilities. The real economy in the use of an additional clerk or foreman is not always comprehended, at times only grudgingly assented to; nor is appreciation always shown of the value of labor-saving equipment and appliances. In later years there has been something of an awakening to the wisdom

of a more liberal policy in these respects, yet the field contains much room for further thought and action.

Drives, originating at headquarters, in connection with the release of equipment, are occasionally carried forward successfully and, for a time, a good showing is made; then the driving force wanes and the standards reached are not preserved. The efforts of the car distributing office should be continuous; constant vigilance the rule; and the aim to bring the agents and their subordinates to that frame of mind that would regard the loss of a day's use of a car as serious as the loss of freight revenue on the contents thereof, for which the agent is personally responsible.

Some of the varied duties and practices of the station agent may now be summarized.

Scales must be kept in balance and protected from weather. All possible precautions must be taken to guard against fire. Material must not be piled within ten feet of track centers, nor must traders be permitted to obstruct tracks while loading or unloading cars. Freight requiring shelter must be promptly placed in the freight house or in cars. Applications for employment with the company by desirable persons living in the vicinity should be encouraged.

The general foreman has charge of the men employed in the freight house and on the platforms, a gang foreman being in charge of each gang, the callers "call off" the name and address of the consignee on each shipment, the number and character of the pieces, etc.; the loaders load them on trucks, the scalers weigh them and the truckers convey them on trucks either to the proper car in the case of outbound shipments, when they are stowed by the stevedore, or to the proper place in the house in case of inbound shipments. The laborers are variously employed.

In the handling of L.C.L. freight, the most economical working of the force is to be found at the large terminal freight depots which include the work of the transfer station and the facilities of the storage warehouse. The labor is most economically used when the laborers work in groups

on the "gang piece-work" basis. In every transfer station, some man shows the greatest ability in loading and should be appointed to a senior position. In every group of such stations, one man will stand out over all the others and his services should be utilized in going around from station to station to superintend the loading for a period. To give him the necessary authority he should be classed as an officer.

Station records, accounts and reports must be written in a neat and legible manner. Erasures must not be made to correct figures but a line drawn through the entry and corrected figures inserted above the original figures. Records to be retained permanently must be carefully filed and in proper order for convenient reference; also tariffs, classifications, circulars of instruction and other publications. Replies must be made promptly to all communications requiring answer and reference made to file, claim or tracer number. When answering correspondence regarding waybills, the complete reference must be given, including initials of issuing line. The use of the pencil is to be avoided; pen and ink, indelible pencil or typewriter should be used. The name of the month should be written, not expressed in numerals. Telegrams should be brief, without unnecessary words or expressions. Unnecessary telegrams should be avoided, and the train mail service used where possible. There should be economy in the use of stationery and supplies and a quantity not to exceed 60 days' supply should be carried and kept up by monthly requisition. Packages containing valuables are forwarded by express. Station agents, upon whom legal process may be served, relating to or affecting property which is in their custody as the representatives of the company, must not voluntarily deliver up such property unless authorized by the company's attorneys. Should a sheriff or other officer having authority seize, under writ of replevin or attachment, or other legal process, any freight or other property, the station agent must at once advise the superintendent and the company's attorney by telegraph, asking instructions as to his legal

responsibility and that of the company. No assignment of wages must be recognized nor must information be given out as to the amount held by the company subject to attachment. Property offered for shipment must be accompanied by a "straight" or "order" bill of lading. The latter must bear the impression of the issuing station dating stamp on the original, duplicate and triplicate, and must not be issued for more than one car. Station agents are bonded by a surety company.

There is a great difference between the volume of business handled at a large terminal freight depot and that handled at a small combination country station, and this difference is reflected in the profitableness of the business handled. It is no exaggeration to say that one-third of the freight depots of the country are run at a loss.

208. Telegraph and Block Operators.—The telegraph operator who handles the train orders is charged with the duty of delivery. Besides the personal and professional qualifications required, he should be thoroughly conversant with the rules and methods prescribed for this service, as well as with the time tables and general train rules and the character and designation of trains. A telegraph operator may do much to keep business moving by advising the dispatcher of arrivals, delays and other things bearing on train movements, which the letter of his instructions may not require him to report. One who does this intelligently prepares and recommends himself for advancement.

The uses of the telegraph are so numerous and diversified that it would be unprofitable to undertake either to catalogue them or to describe them in detail.

It is quite important to impress operators with the gravity of the work in hand. Their apprenticeship and training should be such as to assure this as far as possible, and before appointment they should be thoroughly examined as to their qualifications in all respects, and afterwards constantly supervised by competent officials. Young persons readily learn to telegraph. It is no disparagement to them to say that they have not ordinarily the steadiness of char-

acter and sense of responsibility which we expect in mature years. Without these it is difficult for them to have proper conception of the magnitude of the interests dependent on their attention to their duties and the importance of exactly carrying out details which to them may seem almost trivial. We have here a cogent reason for so systematizing this business as to render its working as nearly automatic or mechanical as possible, thus eliminating as far as practicable the risks arising from the deficiencies of the human agency. In all systems worked by man these risks will be found.

Operators should aim at a high standard of qualification and attention to duty. A careful study of this special work will develop a sense of its importance, leading to better attention to duties and preparation for advancement. Operators will, therefore, do well to make themselves masters of their business, rather than rest satisfied with merely mechanical attention to prescribed methods, without intelligent comprehension of their significance.

There is a disposition among all classes of employees to make the telegraph office a sort of club room, probably because they can there learn the latest news; and on the part of the telegraphers there is a natural inclination to relieve the tedium of their office hours by social chat. Telegraph operators should be carefully guarded against the intrusion of outsiders or employees off duty. Conversation or other interruption may distract attention at a critical moment and cause an operator to write an order incorrectly or to allow a train to pass which he should stop. Nearly one-half of the railroad mileage of the country is now operated by telephone. The use of the telephone has simplified and expedited the business, though it has the disadvantage that all the men on the line cannot "listen in" as with the telegraph, involving the loss of an important educational opportunity.

209. The Crew of the Train.—In the rules and regulations a train is defined as an engine, or more than one engine coupled, with or without cars displaying markers.

It is unfortunate that one has to employ so awkward a

locution as "the crew of the train" to describe both groups of men employed in the working of the train, one of which has come to be known as the "engine crew"; the other as the "train crew." Some of the time of their supervising officers is concerned with the problem of keeping them in harmonious relations.

210. *Fireman.*—The fireman's main job is to keep up a good head of steam, not to waste any of it by popping-off, and to use the smallest possible amount of fuel.

It is too much the practice to employ the casual applicant, to put him on the locomotive and tell him to go to work, with no more training than perhaps three trips over the road under instructors. The natural recruiting ground for employees is the territory served by the company, and the natural recruiting staff the station agents, section foremen, and the officers and men in the service. Through these the road foreman of engines should provide himself with a waiting list and should seek to give the applicants preliminary training, in work about the engine dispatching facilities, the roundhouse, the machine shop, in hostling or as head brakeman, to give them familiarity with locomotives. As Sinclair points out, without some such preliminary training the first ten days of a fireman's experience is likely to prove very trying, and it is here that the labor turnover in the engine crew is found. To ride for eight or ten hours on an engine for the first time, standing on one's feet and subject to the shaking motion, is intensely tiresome, even if a man has no work to do. But he must shovel 6 to 12 tons of coal; the posture of the body while doing this work is new; he must pitch the coal upon certain exact spots, through a small door, while the engine is surging about and he is unsteady on his feet; his hands get blistered with the shovel, and his eyes grow dazzled from the intense glare of the fire. Then come the additional side duties of looking out for signals, train orders and highway crossings, ringing the engine bell or controlling the automatic bell ringer, taking water and fuel, shaking the grates, and, where poor coal with considerable non-combustion is used, clean-

ing the fire. A few weeks' practice makes all this easy work. The pay during this apprentice employment is, and should be, good, as compared with other competing employments and the reward for advancement material.

The men selected for employment should be active and of physique equal to the requirements of the physical examination, with mental alertness, good education and judgment, and good temper. Once registered the new fireman looks over the bulletin board and from the engine-board ascertains the engine to which he is assigned. He sees that proper supplies, including full tank of water and tools are on the engine; that the grates and operating gear are in good order, assures himself as to the condition of the ash-pan and dampers, and of the fire, and that there is a sufficient live fire on the grates to keep up steam while the locomotive is starting the train, avoiding as much as possible opening the fire door while the exhaust is strong. On the road he watches the signals and calls their position to the engineer. At the end of the run he sees that tools are properly put in their places, flags taken down and just sufficient fire to be cleaned without any excess unburned coal. Every trip brings new experiences, every day adds to his knowledge of the intricate machine he is learning to manage. Week by week he accumulates knowledge that will eventually make him a first-class locomotive engineer. In this he should have the guidance and encouragement of his engineer, the oversight and direction of the traveling fireman and the road foreman of engines. Every six months his acquired knowledge should be reviewed by written examination, first the flagman's duties, then mechanical and air brake, and finally the book of rules, until his understanding of the locomotive and the book of rules meets the requirements for advancement.

211. *Engineman.*—The engineman's main job is to get the most work out of his locomotive at the least cost, always with an eye to the safety of his train under the rules and under the conditions of block signaling. Argument may be maintained as to the relative responsibility in train-working

of the engineer and conductor on single-track, constituting approximately 87 per cent of our main-track mileage, but more than half the freight ton mileage is moved on less than 10 per cent of the road mileage, and here there can be no question of the unequal burden so confidently and successfully carried by "Old Eagle Eye." Upon the loyalty, intelligence, and the care of the engineman, depend largely the safe, punctual, and profitable operation of the railroads. He should be distinguished for his knowledge respecting the engine and the working of the traffic.

I took Mr. McKinley to Washington for his first inauguration, and as we walked down the platform he stopped, shook hands with the engineer, thanked him for his service, and taking the carnation from his button-hole asked him to give it with his compliments to his wife. It was not "politics" but a very real display of human understanding. As we passed along he said, "Well, that is the real man after all."

Capacity to handle a locomotive can be acquired in a few weeks' practice. Operating the throttle, reverse-lever, air brake, feed water and lubricating equipment make but a scanty demand. When one thinks of the old ladies of 60 and the young ladies of 16 who drive automobiles over our crowded streets after a few days' instruction, it would seem as though the entire force of engineers might be recruited overnight from among the chauffers. At the beginning, engineers were made from shopmen, a few days' practice in moving locomotives round in the yard being considered sufficient for road service. Other qualities than mechanical ability were, however, found to be necessary to work the locomotive over the road safely and on time. Perfect control of speed, of facility in handling a train, insight into the best methods of economizing combustion and steam, the whole magazine of practical knowledge which enables an engineman to meet every emergency with calmness and promptitude, are obtained only by years of experience on the footboard, amidst many seasons of fair and foul weather and by assiduous observation while there. And

this process of education should never cease. Ask questions; attend the air brake and train rule instruction classes; observe the shop operations; read the instructions issued by manufacturers of superheaters and other accessories that reduce work and make for economy; study the books which contain in condensed and logical form information based on the experience and discoveries of the hardest workers and thinkers of the past, the products of long years of toilful experiments and patient observation. The knowledge so acquired should be passed on as rapidly as possible to the firemen. Engineers should feel themselves responsible for the education of their associate.

After registering and examining the bulletin board and general orders, track and bridges under repair, slow orders, etc., and comparing his time with standard clock, he notes his assignment on engine board. Except when relieved by hostlers, who are rapidly taking over this work, he then inspects the interior of fire-box, sees that the tools necessary are on his engine, starts the air pump and lubricator, oils the engine and tests the air brakes. Where the actual work has been done by the hostlers, the engineer is not relieved from the responsibility of knowing that it has been done properly. Inspection while oiling indicating all parts working satisfactorily, the locomotive is taken from the house and coupled on the train. Time is here compared with conductor and fireman. It is when starting a train that the working of the locomotive may best be studied.

On arrival at the terminal, a second examination of the crown sheet is made and the engine left on the pit with three gauges of water.

Enginemen are required to visit the air brake car once each year for the lectures and instructions by the air brake instructor; to visit the rules car once in two years for eyesight and hearing tests and oral examination of the book of rules; and, if out of the service for 60 days, they must visit the rules car and take an oral examination on the book of rules.

These two men, the engineer and the fireman, then con-

stitute the engine crew and it is hard to understand why any more men should generally be found on it. On the great bulk of the mileage of the country their duties are light and the work now done by the head brakeman could be readily undertaken by the fireman; upon large locomotives where the labor of shoveling the coal is heavy, and on crowded tracks or on trains where much incidental work is involved, an assistant fireman could be added to the crew and the work apportioned as circumstances indicated.

212. *Water.*—The work of the engine crew consists largely in handling water and coal for the production of steam, use of lubricants to overcome friction, and the starting, stopping and working of the locomotive to move the train. As Baker points out, water is, of all liquids, the most powerful absorber of heat, the amount of heat and energy that may be stored in it being almost incredible. The work of starting trains, accelerating their speed, climbing grades, drifting down hills and into stations with the steam shut off, necessitates great irregularity in the application of power, and, as the source of power is heat, it is well to make use of every opportunity that offers to gather in a reserve store of heat. Starting trains is the hardest work that locomotives perform, and, unless they are assisted during this emergency by stored heat, the consumption of fuel is extravagant. Before starting, the boiler should be properly filled with water, heated to the proper temperature, the fire should be properly prepared, and the injector or feed water pump should not be operated until the train has been forced into speed. The amount of water to be carried under various conditions of work should be carefully studied, consideration given to every influence exerted in producing dry saturated steam and, in time, a high degree of superheated steam, and in converting its velocity pressure or force into work. There should be a good supply of water in the boiler when beginning the ascent of a grade, as the injection of cold water checks the formation of steam. While the water should never be allowed to fall below a good margin of safety, the boiler should not be so

full that the steam will carry water over into the superheater or cylinders when the engine starts. The level of the water with relation to the top of the crown sheet is shown in the water glass and can be tested by the gauges. The first gauge is ordinarily located about three and one half inches above the highest point of the crown sheet and the other two at similar intervals, though this varies slightly with different manufacturers.

213. *Coal.*—The different fuels, that is, bituminous coal or anthracite or a mixture of the two, lignite, and fuel oil, as well as the different methods of burning them, as by hand or mechanical stoker firing on grates or in retorts, or in powdered or gaseous form in suspension, require different equipment and different methods on the part of the fireman but the object to be obtained is the same, the most effective combustion, which means the maximum percentage of carbon dioxide (CO_2) and the minimum carbon monoxide (CO) and free oxygen (O).

The coal, when placed on the engine, should preferably be broken down not larger than the size of an egg, thereby offering greater surface area to the heat and facilitating its being scattered more uniformly over the brightest spots in the fire. On large locomotives it is moved forward by gravity or by mechanical devices, or coal passers, so that it can be reached by the fireman without walking into the tender. A shovel holds, when ordinarily full, from 11 to 14 pounds of coal. Generally at intervals of about three minutes, four or five shovelsful will be scattered over those portions of the surface of the fire which require replenishing. The coal should be so thrown as to strike the fire bed and not to strike the flues, fall on top of the arch, or in a manner that will permit the fine particles to pass through the flues unconsumed. Furthermore, live fires should be kept along the sides of the fire box and in the corners to exclude the cold air and to avoid chilling the combustion, fire box and flues, and with special attention to keeping the fire alive at the throat-sheet.

Heavy firing must not be indulged in, as it results in

poor combustion and black smoke, the cooling of the fire box and flues; contraction, followed by an intensely hot fire, causing expansion, results, in time, in cracked firebox sheets, leaking flues, broken stay-bolts, and general injury to the firebox, tubes and flues.

The coal should be fired in small quantities and regularly, allowing the fire-box door to remain closed a few moments between shovelsful for the furnace to regain its temperature. When the train is well in motion and the reverse lever pulled back to short cut-off, the fuel can be put in under the more favorable conditions of a softer draft. Care must be taken to keep the bed of fire thick enough, and of uniform depth over the entire grate surface to prevent the access of too much air.

The importance of providing for a full admission of air through the grates in quantities sufficient to effect combustion as nearly perfect as possible should never be overlooked. To this end adequate provision should be made by designers for the maximum air openings through grates and ash pans, an important detail that has been greatly overlooked. To perform their part, the grates must be shaken as necessary to keep them free of ashes and clinkers. To remove clinkers from the fire-bed and hoe out the ash-pan is a disagreeable task but should not be shirked. Ash pans and fires must not be cleaned near any bridge, culvert, depot or building, or on any frog or switch, and the fire should be thoroughly drowned out with water before being left, in order to avoid burning cross ties or spreading fires. The steam pressure should be kept within the limits of five pounds and not changed rapidly either way. When the boiler shows indications of blowing-off, the steam pressure should be lowered by feeding water into the boiler, or by opening the door a few inches. Reynolds says that when heat, water and fuel are being thrown away in steam through the safety valves it is positive proof that either the locomotive is too small for its work, or too great for its man. Frequently, with a light, clean fire, when the locomotive is standing and the blower on, a drumming noise

is heard; it may be prevented by closing one or both dampers, or opening the fire-box door sufficiently, whichever is more effectual.

214. *Steam.*—In the early days of steam locomotives a comparatively low pressure of steam was used, which necessitated allowing the steam to follow the piston at boiler pressure nearly or quite the entire length of the stroke. Failure to utilize its expansive properties resulted in very extravagant use of fuel. With higher pressure it was found that more work could be done with a great deal less steam by cutting off the supply early in the stroke and allowing the steam to spend its expansive force in pushing the piston the remainder of the stroke. In starting trains it is not possible to use to any great extent this expansive force of steam, but in forcing trains into speed, and pulling them over the road, it offers the greatest opportunity we have to economize the use of steam, fuel and water. While performing such work, the engine should be run with throttle wide open, allowing the steam to enter the cylinders as near boiler pressure as possible, and then cutting it off as early in the stroke as possible and consistent with the work to be done. The practice of running the reverse-lever in notches, causing the valves to cut off at, say, from one-third to one-half of the stroke, and then regulating the power by the throttle, by increasing or decreasing the pressure of the steam in the cylinders, is very wasteful and wrong, and is to be avoided as much as circumstances permit. A slight opening of the throttle will wire-draw the steam and cause it to enter the cylinders at a lower pressure than that of the boiler, and thus deprive it of much of the potential energy with which it has been invested.

Many road foremen of engines question the wisdom of running at all times with wide open throttle. They express their opinion in the phrase—low piston speed, wide open throttle; high piston speed, regulated throttle. Of course this applies only after trains have been started. In starting trains it is necessary to work the locomotive full stroke, and throttle the steam so as to prevent the slipping of driv-

ing-wheels which is not only liable to injure crank pins and rods, but affects the fire injuriously and causes waste of fuel.

Some enginemen practice forcing their trains into speed from stops in as short distance and time as they can, and this is responsible for much unnecessary waste of fuel.

Cylinder condensation limits the degree to which the expansive force of steam may economically be used. It is caused by the metal of the cylinder absorbing a certain amount of heat from the steam and conducting it away from useful work. The general use of superheaters has largely overcome this trouble although much still remains to be done in the way of increasing superheat temperature and preventing radiation losses.

Contracted exhaust nozzles being necessary to free-steaming locomotives, the use of steam of high pressure with early cut-off reduces exhaust and causes less back pressure in the cylinders. Escaping from the nozzles at a lower pressure, the force of the exhaust is less and produces a milder draft through the fire, burning less coal, and allowing the heat and products of combustion to pass from the fire box and through the flues with a slower motion. Remaining longer in contact with the heating surface more of the heat is imparted to and absorbed by the water in the boiler.

215. *Lubrication.*—Friction is a resisting force which always tends to prevent or retard the motion of bodies in contact. The objects of lubrication are to reduce friction and prevent development of destructive heat, and are accomplished by interposing between the smooth rubbing, rotating and sliding surfaces of machinery, such as journals and bearings, pistons and cylinders, a film of oil of sufficient "body" to keep the surfaces between which it is interposed from coming together in metallic contact. The use of more oil than is necessary to effect this purpose is waste and should be avoided. Temperature affects the lubricating quality of oil, and consequently friction of rubbing surfaces, very greatly. By the way trains drag for the first few

miles after a delay of 30 minutes in cold weather, enginemen are made painfully aware of the action of friction due to the congealing oil in the journals. Groaning valves and pistons exposed to steam indicate the opposite effect of too high a temperature such as will cause the oil to deteriorate through carbonization.

Every movable part and every oil-hole should be inspected and oiled. Oil-holes stopped up should be promptly and thoroughly cleaned. Driving box, shoes and wedges, and the valve gear generally need oiling only once every 100 miles. When driving-wheel flange oilers are provided, they should be of the automatic type. The economical use of power depends greatly upon the use of lubrication for the machinery and wheel flanges and rail, and every movable part that will create friction should be kept well lubricated with oil or grease.

Since so much depends upon proper lubrication, oiling and greasing should be invariably attended to before the commencement of the trip, and "oiling around" should never be done hurriedly, but carefully and deliberately without waste, looking well to the general condition of the locomotive, the temperature of the journals, pins, and motion gear parts, and to the appearances of the lubricated surfaces. Much of the oiling is now done through sight-feed lubricators, the glass permitting the dropping oil to be observed.

216. *Working the Locomotive.*—There is a sad lack of good judgment on the part of most enginemen as to time and speed, and this is especially true when running at the low speed of freight trains. For this reason it is very desirable that a reliable speed indicator and recorder he added to the cab fixtures; otherwise the engineer is in danger of arriving at stations too early or too late, running too fast at times, too slow at others. The skillful engineer in starting his train avoids the jerks that are so destructive of the draft rigging, prevents slipping by reduction of steam pressure in the cylinders, or by the use of sand, which should be restricted to cases where it cannot be dispensed

with as it rapidly wears the tires, while the sudden check causes a great strain on the machinery. He avoids running past stations where stops are to be made, and does no unnecessary braking, especially of a character to slide the wheels, so severely damaging to both wheels and rails. The passing to and from curves, and through turn-outs, calls for a high exhibition of skill that only the most competent engineers can show. While running on curves the engine crew should carefully observe the behavior of the train, to discover hot-boxes, derailed trucks or other mishaps demanding prompt attention.

The business at stations or sidings should be dispatched in the least time practicable. Whatever time is lost here by loitering must be regained by so much increase in speed. Fuel and water should be taken, the bearings and running gear of the locomotive and tender inspected and oiled when necessary with the least delay, and movement begun on signal, starting as promptly as a passenger train.

Before entering a long and sharp descending grade where a heavy call will be made on the braking power, it is well to allow the train to stand for 10 minutes to give time for inspection of brake apparatus, to turn up retaining valves, and make sure that all draft and running gear is in good condition. If the grade is longer than ten miles, inspection should be repeated on the way down.

Where the engine is turned over to a road hostler, it is the practice to give him a slip showing parts to which special attention should be given on account of renewals. Usually these slips are given to the roundhouse foreman or the engine dispatcher.

Before going out on his run, an engineer should examine the work-book to see what repairs were last reported as being necessary, and what has actually been done. Because of increased liability to friction, repaired machinery parts may require extra road attention.

There is an important difference between a first-class and a fair locomotive engineman, and of course a greater difference between a first-class and an ordinary one. It

is not sufficient to stimulate effort, study and fidelity to reward the best and most competent with commendation and to bring the careless and unskilled under discipline. We should work out some more adequate compensation. The engineman should know how to feel his locomotive and apply the power judiciously to the work, and the skill to do this requires education, experience and good judgment which should be suitably recognized by distinction and pay. The freight engineman has always before him the possibility of promotion to passenger engineman. Here his rate of pay is high, his hours are short, and his work neither monotonous nor arduous; his lot is one that may well be envied by the majority of workmen.

217. *The Train Crew.*—The train crew is responsible for the condition and working of the train. Like the fireman, the brakeman is usually selected from among chance applicants, and, after several trips over the road as an observer, is put to the job, being, as a rule, left to learn the duties by observation. Here, also, an unreasonable amount of labor turnover is located, and, under the circumstances, is to be expected.

Like the road foreman of engines, the trainmaster should recruit his men from along the line of his road, where they and their families are well-known and already have a substantial stake in the community. The children of employees are in a sort of apprenticeship from their birth; they have opportunities for learning many details which others can only acquire after considerable service. It is an inducement to continuous and faithful service if the employees understand that these chances for a start in life are held open for their children. The trainmaster should have a suitable waiting list with such preliminary training as may be given. Systematically, and at intervals, not longer than six months, the brakeman should be examined on the book of rules and air brake practice until he has acquired the knowledge essential for promotion. The introduction of the air brake has greatly decreased the work of the brakeman, while the automatic coupler has removed what was

before its use the very great hazard in coupling. His duties, though much lessened, are still important.

There was a time when the conductor hired his own brakemen; now, with the growth of the business, he is supplied with them, but their education is largely at his hands, and he, better than any one, knows their character and capacity, and his recommendations regarding them should be solicited and given great weight. Advancement should not be left solely to the working of seniority, which has been the real set-back to the worthwhile man. More than any other one thing it would seem to have lowered the efficiency of the service. Promotion should be a reward —reward for courage, endurance, readiness of resource, intelligence, application and steady perseverance.

The head brakeman couples the engine to the train, uncouples and couples at water stations, and attends to standpipes, opens switches at sidings, and assists in setting off and picking up cars, and while moving through yards must be out on the train to receive signals from the rear and relay them to the engineman. Where grades make it necessary, trainmen are required to be out on top setting up or turning down air brake retainers. The flagman sees that the caboose supplies are on hand, and when moving through yards is out on the train and assists in switching, unless occupied in protecting the train when on the main track. A distinction in pay was for many years made between the flagman and the other brakemen, but was discontinued in 1913. It is upon the flagman that the conductor, while not neglecting the others, should largely concentrate his instructions. The conductor reports to the yard office, compares his time with the standard clock; with the yard clerk checks the car numbers against the yard clerk's records; receives from him the bills (or their equivalents) for all the cars in the train, and reports ready to go. He enters in his wheel report the number of each car and the initials of the owning line, its destination, its empty or tare weight, the weight of the load, and the sum of these two or the gross weight of the car and the stations

from and to which moved. This wheel report is forwarded to the car accountant with notation of any seals missing or broken. Upon arrival at the division terminal the conductor and brakemen register at the yard office, hand in reports of delays, hot-boxes and accidents, if any, with train switch list, the engineer and fireman hand in their time slips, the names of all are posted on the "in" register and they are off duty until summoned by the caller.

The conductor, especially on single track lines, is in an important position. He must keep the time-table constantly in mind, not overlooking a single figure; he must not only see that his own train is exactly on time, but he must know where every train holding superior rights or moving in the opposite direction will meet and pass him. All matters and all differences are referred to him, and he must be prepared to meet every emergency that may arise with knowledge, judgment, promptness and nerve. He must see that no time is lost at stations, must be watchful of the condition of each car, be alert for signals from his engineman, from stations and from towers, and have at his fingers' ends the rules and regulations.

The small obstacles to the prompt movement of freight are many. They differ at every point upon the line. The conductor will discover them by patient investigation, and where he cannot overcome them should report them in detail with his recommendations for their removal. Not the least frequent cause will be found in "man failures," due generally to misunderstandings of instructions, and these he is in an especially advantageous position to detect.

In the working of the train, great attention must be given to the journals. The journal box should be dust- and oil-tight, should properly distribute the load and accommodate itself to any wear of the bearing. If the journal becomes overheated it is because of mechanical defect or defective lubrication. A large percentage of hot-boxes could be prevented by the proper application of a small quantity of oil before the surfaces of the bearings or journal have become injured. When using new waste, thoroughly saturate

it before placing in service. When the top of the waste has formed into a hard gummy surface, it not only acts as a poor lubricant next to the journal but prevents the oil at the bottom of the box from reaching the journal. The waste should then be removed and the box repacked. The job of cooling a hot-box with buckets of water and repacking it with waste and thick, black, evil-smelling oil is a dirty and disagreeable one, but if not done in time the car may be set on fire or the axle broken off. The bearings themselves must be removed when made defective by overheating or too thin from wear; the axle, too, may develop defects that require its removal. This matter of lubrication and the conditions of the journal bearings and axles require constant and systematic attention. Indeed, success in train working is only obtained by careful attention to small details; nothing which is not exactly right should be permitted to pass; scrupulous care should be exercised in watching the behavior of the brake apparatus, the running of the cars, the handling of the switches by the brakeman and the prompt movement in and out of the sidings. Any irregularity in working should be promptly investigated to ascertain the difficulty and the least possible time consumed in providing remedies.

218. Changing Conditions and Practices.—The earlier works abound in descriptions of the hardships of the train crew. While the sudden stop that sends out a flagman with protecting signals may give him only a pleasant walk along a meadow-lined track on a rare June day, it may cause him to crawl in the piercing wind of a dark winter night over sleety ties on an ice-bound trestle. He may be required to ride the decks of the cars with the mercury down to 20 or 30 below zero, running over the tops of the cars because it is so much easier to keep the footing running than walking, and safer to jump from car to car than to step deliberately across the space between them, the black smoke and steam from the engine meanwhile blinding him as it rolls back over the train in dense volume. It is said in mitigation that the exercise of setting up brakes, brake stick

in hand, on down grades and throwing them off for up grades and level stretches kept him in a glow of warmth. But the business was nevertheless one of great attraction; the glare of the head light, the rush and throb of the locomotive, the connecting rods and driving wheels of which seem instinct with nervous life, the final whirl of dust in which the red tail lights vanish almost as soon as they are seen—all this excited admiration. To feel one's self part of an organization whose vigilance never relaxed either by day or night, in summer or winter, whether through the drought of the burning sun or the torrential rain, on the snow-capped mountain or across the alkali desert, were among the reasons advanced to explain why, once a man had passed the first few hard days of first experience, he was never likely after that to change his calling. Meanwhile all the talent and administrative ability on the railroads have been industriously employed to improve matters, to raise the character of the service to the highest standard. Many comforts and conveniences have been provided for engine and train crews and have greatly reduced the arduous physical labor, as well as relieved them from much sustained watchfulness. The work formerly required of enginemen to set up driving box wedges, adjust the main and side rod brasses, repack valve and piston rods and engine truck, driver and tender box cellars, refill and adjust various rod and other oil cups and to supply lubricants to the valves, cylinders and various other parts of locomotives and tenders, has been largely eliminated through the inauguration of the use of adjustable driving box wedges, of solid rod brasses, of valve and piston rod metallic packing and of grease lubrication. Other work formerly done by the engineman has been transferred to the enginehouse inspection and repair forces which now assume the work formerly done by him of cleaning head lights, putting in water gauge and lubricating glasses and the like. The modern locomotive is equipped with boiler and engine indicating apparatus such as steam and air gauges, automatic lubricators, water gauges and other fixtures which are all

conveniently located and placed in direct line with the engineman's vision. The cabs are equipped with comfortable seats, many are steam heated and fitted with electric lights and have power reverse gears, automatic air sanders, air-operated bell-ringers and cylinder cocks, improved injectors and hydrostatic or force-feed lubricators, speed indicators and recorders, special cab doors, windows and arm rests, clear vision glasses, wind deflectors and various similar devices providing greater security and comfort and relieving the engineman of manual labor. Improvements which have been made in boiler water supply and in the use of superheaters have also eliminated the trouble previously experienced with boilers foaming and priming, while the better design and the use of better material, high grade alloy metals, autogenous welding and the like, have greatly reduced mechanical troubles, formerly experienced while on the road, due to fire-box and flue leakage, broken parts, heated bearings and steam failures.

The mechanical work of the engineman to-day is largely to receive his engine at some convenient location, look it over, supply a small amount of oil to different bearings before he goes out on the run, start, control the working and speed and stop the engine and train as required between terminals and at the destination, to make a general inspection and report of work which he has noticed, from the action of the locomotive during the trip, should be performed, the detailed inspection and work reports being made by the enginehouse inspectors. As to the transportation work of the engineman, the extended use of separate tracks for trains moving in different directions, and where the traffic is dense for passenger and freight, both fast and slow, of separated railroad and highway crossings, of automatic and block signals, of interlocked grade crossings, junctions and yard apparatus have relieved the engineman of stopping to receive orders and at meeting points and crossings, and in a thousand ways reduced the hazard of the operation. From the beginning the engineman was, of all railroad men, in the safest position, and he has secured

large benefits from continued improvements. His position continues as in the past, the most desirable in the train service.

In former days the fireman, in going on duty, cleaned the fire in the engine which had been left banked, cleaned out the flues, got the oil and waste, the firing and other small tools and supplies, wiped the engine both above and below the running board, polished all brass (the bell, cylinder and steam chest, boiler bands, number plate, dome and flagstaffs, steam gauge, lubricator, air gauge, steam heat gauge and gauge cocks) both inside and outside the cab, painted front end and stack, wiped off tank, assisted in switching train yard for trip, kept watch of the rear end of train while on the road, observed the signals and assisted in holding train down grades with the tender hand brake. Also while switching he had to use tender hand brakes for almost every cut that was made. After completing the trip, the engine was put on the ash track where he cleaned the fire and banked it for the night, filled the sand box, and, in many cases, assisted in coaling the engine for the following day. To-day practically all this work is taken over by the enginehouse and storeroom forces, the yard and train crews. Indeed, comparing the present work and pay of the fireman, with those of the engineman, the fireman appears to have the more greatly benefited from modernization of practice.

Through the application of superheaters, firebrick baffle walls, better insulation and improvements in fuel and heat saving and utilization devices, the amount of fuel to be fired per unit of work performed by the locomotive has been materially reduced. Furthermore, there are now in the United States about 4000 locomotives equipped for the use of oil as fuel, which requires practically no manual labor on the part of the fireman, and there are also about five thousand large coal-burning locomotives equipped with mechanical stokers, which greatly reduce the physical labor of firing. In other cases firemen are given assistance through the use of power coal pushers in the tender, or in having coal passers shovel down the coal to within easy

firing reach, while in some cases a second fireman is provided. The fireman is further relieved of work by the application of power grate shakers, automatic fire-doors, bell ringers, etc., and by changes that have been made in the rules and regulations, while improvements continue to be made, such as the application of feed water heaters, waste heat economizers, the use of powdered fuel and similar devices that will further reduce fuel consumption and the call on manual labor. Many of the mechanical and operating conveniences that have been provided for the engineman make the work of the fireman more comfortable. He is relieved of all hand-braking on the tender and the switches are thrown by the interlocking operators or by the brakeman.

The work of the train crew has been revolutionized by the introduction of the air brake, the automatic coupler and interlocking apparatus. The Loughridge chain brake, worked by the engineman from the locomotive, was apparently the first improvement over the hand brake, but this, and the Gooddale, Ambler, Cramer and other devices, failed in practical service. On April 13, 1869, George Westinghouse patented his air brake by which power from the engine was transmitted by compressed air, carried through hose and acting upon every car in the train. The first trials were made on the Pan Handle Division of the Pennsylvania in September, 1868, and his early success was due largely to the appreciative and courageous officers of that company, Scott, Cassatt and others, who perceived its merit, realized its necessity for the future and aided in securing its adoption by all the railroads in the country. On March 5, 1872, he brought out his triple valve attachment, making the action of the brake automatic. It remained to avoid skidding the wheels and this was brought about by a contrivance which allows the air to leak out of the brake cylinders so as to proportion the pressure of the shoes on the wheels exactly to the speed with which the latter are revolving. The tests made in 1886 on the Burlington, and in which there were entered the American Brake

Company's direct buffer brake, Eames automatic vacuum brake, Rote direct buffer brake, the Widdifield and Button friction buffer brake and the Westinghouse automatic brake, disclosed defects when applied to heavy freight trains that made it seem for the moment the air brake was a failure. These were overcome by Westinghouse's development of his quick-acting brake, acting instantaneously on each car on the application of the power, and in case the train should become accidentally divided, acting instantaneously in each part of the train.

No one matter perhaps has interested more inventive talent than the coupler, there having been issued in connection with it more than 3000 patents. Ezra Miller was the first to bring forward a close connection between passenger cars and an automatic coupling in 1863. Janney improved on this device and, about 1879, adapted it to freight cars. The master car builders at their meeting at Minneapolis in 1887, adopted a resolution offered by E. B. Wall for a standard form of coupler acting in a vertical plane. This device did away entirely with coupling by hand, stopping the casualties to which brakemen were continually exposed in coupling and uncoupling freight cars.

Fixed signals were provided on the Grand Junction Railway, England, in the form of discs as early as 1837. They were carried on poles about 12 feet high with a lamp on top, and were turned through a quarter circle by a lever at the base.

About 1842 the semaphore signal was introduced showing three positions—clear, caution and danger. Some connecting up of wires may be traced back to 1846, but the first successful attempt to install an interlocking was made by John Saxby at the Bricklayers' Arm Junction, London, in 1856. Originally the locking was attached directly to the lever, but to relieve the strain was later applied to the latch of the lever. The Pennsylvania Railroad installed the first interlocking in this country near Trenton about 1865, but it was not until after the exhibition of the Saxby and Farmer machine at the Centennial Exhibition, Phila-

delphia, 1876, that they commenced to come into general use.

While on American railroads the movement of the trains was, at the beginning, regulated by train orders, and for protection reliance placed upon flagging, in England quite a different practice developed.

The "Staff System," for single line working, was originally devised by Henry Woodhouse for working the long Standedge Tunnel on the Huddersfield and Manchester Railway. This was subsequently expanded into the "Train Staff and Ticket System" and later an improved "Train Tablet System" came into use. None of these had any extended use in this country. As early as 1842, W. F. Cooke devised a "Manual Block Telegraph System," improved in 1853 by Edwin Clark into an "Absolute Telegraph Block System"; the "Three Wire Block System" for double track with a special code of electric bell signals. The manual block of Cooke gradually gave place to the "Automatic Electric Block System" with rail circuit, and this is the only form now generally used in this country.

While the reliability of the machine is substituted for the uncertainty of the man, its efficiency depends upon its maintenance. Human agency is not eliminated; the responsibility is merely transferred from one to another set of men.

Unless one has lived through the period of the introduction of these devices, it is impossible to realize the change they have effected in the work of the crew of the train. Before the introduction of the air brake the general practice was to equip the caboose with a long bell cord, which, after the train was made up, was strung over the top of the cars by the brakeman and connected to a bell in the cab of the engine. This cord would then be drawn and weighted down at the caboose end with an indicator so that in case the train broke in two the conductor or brakeman in the caboose would be notified and would get out on the train and set the brakes. On other roads the head brakeman was required not only to keep a lookout for signals ahead, but

also to the rear, in order to make sure that the train was intact; at night this was indicated by the marker lights. The head brakeman was held to be disgraced if the front end went more than a mile after the train had parted without his discovering it. The conductor and the rear brakeman knew every sag in the track, and watched for the jerk when the slack ran out. If they did not get the jerk they knew that the train was in at least two pieces. Skillful handling by all members of the crew of the train was called for when the train broke into three pieces.

The air brake has eliminated all this work and hazard, and the term "brakeman" on a freight train is now largely a misnomer. It is the engineman who controls the application and release of all train brakes from the engine cab, except in case of the train parting, when the brakes are automatically applied. The use of the old link and pin type of couplers called for high dexterity, agility and courage, the risk of accident was very great and nothing has so ameliorated the work of the train crew as the introduction of the automatic coupler.

The flagman handled the supplies—links, pins, tail pins and keys, brasses, jacks and drawhead spindles.

The conductor reported for work one hour before leaving time, checked the waybills with his cars, saw that hand brakes and everything were in proper order, assisted in making up his train, and then reported for orders to proceed. In the winter he made sure that the brake shaft and dogs were free from snow and ice. A runaway train or cut of cars was his responsibility. Cars in transit were not set out on account of hot-boxes or journals or from drawheads pulled out; these he cared for or replaced. He cleaned up derailments and minor wrecks.

Along with these major improvements has gone the development of many other safety appliances, and a standard practice is now maintained in the application of running boards, hand holds, ladders, steps, coupler unlocking and other devices, insuring uniformity in practice and adding to personal safety. The train crew no longer lives generally in the caboose when away from the home terminal, but that vehicle is comfortably

equipped and usually provided with an air gauge which registers the air brake train pipe pressure. The head brakeman, as a rule, rides in the locomotive cab, and one railroad at least, using two firemen on its large coal burning locomotives, has built a small compartment on the tender equipped with steam heat, electric light and upholstered arm rest and seat for his accommodation.

The capital cost for providing these several appliances has been very great. For a locomotive it will amount, at the prices of 1914, to about $2995, or a total of $62,000,000, and for a freight car to about $77, or a total of $190,000,000; automatic block signaling $1450 per mile, or a total of $90,000,000; interlocking $530 per lever, or a total of $76,000,000, or a total capital investment of $418,000,000. The annual interest, replacement and repair cost on the same bases would be not far from $72,000,000.

The railroads expected to recoup a part of this interest and annual outlay by economies of service and a part by reduction in forces. This last was defeated by the action of the labor unions, aided by legislation secured by them through well-organized lobbies.

The engineman and conductor may be regarded as essential. Following the panic of 1873, the locomotive engineers made a proposition to the Pennsylvania Railroad, and I suppose to other roads, that the position of conductor be abolished, the engineman assuming his duties and dividing his pay with the company. The company considered the plan unworkable. At first blush, it would seem as though it might find a place on some of the single track lines, but it is here that the conductor has proved most valuable.

There would seem to be no justification for two firemen on any locomotive. Where the fireman needs some relief, and such cases must be very unusual, he should be supplemented by an assistant fireman. It would seem logical that there should be no one on the engine but the engine crew. On the great bulk of the mileage, the head brakeman might well be eliminated and the fireman take over his few duties. Where the work is too heavy to admit of this, an assistant fireman could

be added to the crew to assist the fireman to do the work now done by the head brakeman.

There never was any justification for the third brakeman on through freight trains; he and the so-called "full-crew man," should be eliminated. The necessity for a flagman, like the necessity for an assistant fireman, should be determined by the conditions, each run for itself.

We would then have on most of our lines of light traffic a crew made up of engineman, fireman and conductor, and the largest crew on the most crowded lines would be no more than an engineman, fireman, assistant fireman, conductor and flagman.

Here is the possibility of a very large saving in wages, a part of which could be utilized to maintain a high wage scale for the men in the service, which is most desirable.

219. Requirements and Education.—The applicant for position as fireman or brakeman, if satisfactory to the employing officer, after an interview designed to develop his past history and qualifications, is given an educational test in simple sums in addition, subtraction, multiplication and division, is required to read several paragraphs from the book of rules and to write out Rule 99. This satisfactorily accomplished, he fills out a standard formal application for employment and authorizes the company to make inquiry into his past record, furnishing the names of five persons as references. He is then examined by the company's surgeon as to his physical condition, hearing, vision and color perception. The rules examiner devotes six hours to the new recruit, one-half the time in studying rules that will be brought into play with his first trip and explanations of their reason, and one-half to a general explanation of practices and the things with which he will have to contend. Applicants to be firemen and brakemen are furnished with a time table and a book of rules, and also with a question book containing inquiries designed to prepare them for the written and oral examinations that will be conducted in six months to qualify in the flagman's duties. If a fireman, he is given a book covering mechanical and air brake questions.

These preliminary matters having been attended to, the fireman is notified to the Road Foreman of Engines and assigned to run with a designated engineman, and under the instructions of the traveling fireman. After two round trips, if satisfactory, the trainmaster is advised, the man is placed on the extra board and given a number on the roster. At the end of six months he takes the rules examination for qualification as flagman, and in 12 months the written and oral first year mechanical and air brake examination. Twelve months later, he takes the second year written and oral mechanical and air brake examination. The third year examination embraces further mechanical and air brake questions, and his final examination for promotion to engineman taken then, or later, covers his duties very completely.

Similarly, the candidate for brakeman is notified to the trainmaster, is assigned to some particular conductor with whom he makes two round trips, and if O.K.'d, is placed on the extra board and given a position on the roster. After six months' service and passing the flagman's examination, he is instructed in the essential parts of the air brake equipment with which he must be conversant for the safe operation of trains; the air brake pipe with the conductor's air gauge, brake pipe pressure, brake pipe connections and conductor's emergency valve; the triple valve; the auxiliary reservoirs; the retaining valve; the cut-out cocks and bleed cocks; the brake cylinders and brake leverage; the air signal; hose and its connections. A final examination on the air brake and a written and oral examination on the rules qualify him as a conductor.

Promotion according to merit is the order of nature and it should be so in the railroad service. The deadening consequences of the unvarying application of the seniority rule are very apparent. A decent regard for length of service may well be insisted on, but it should not be the controlling element. I used to examine the five oldest men on the roster and then promote the one who both passed the best examination, and was best thought of by his immediate superior officers.

On the Deleware and Hudson, every man in the service is

required to pass an oral examination on the book of rules every two years, and likewise any person absent from duty through any cause for sixty days. The final examination of 5000 employees for hearing, vision and color perception was completed this year in three months.

220. The Work of the Crew of the Train.—Such being the history of the occupation, and such the present conditions, it is of interest to see how the time of the crew of the train is occupied while making a trip. Figure 64 gives the results of some studies made in 1913 in the preparation of testimony to be presented in the firemen's arbitration case and is confirmatory of the results of similar studies I had made in 1898. The situation has been recently checked over and found not to differ materially.

Sob-stuff orators have drawn harrowing pictures of the work and the conditions under which it is done. Much misunderstanding exists and a great deal of misplaced sympathy is excited by false and distorted statements. Much has been done to relieve the men of severe muscular exertion; to increase both the convenience and the comfort of their surroundings. Few, I think, realize how little of the time of these men is actually occupied in physical labor. As will be seen, the conductor and flagman have very light work, the former making up some reports and being responsible for the safety of the movement. The first and third or middle brakeman do almost nothing, and the existence of the third or middle brakeman is purely parasitic. The work of the engineman is exacting, but it is not laborious, and he, too, is responsible for the safety of the movement. A great deal of sympathy has been excited in the interest of the fireman and this has been played up very successfully in securing advanced pay and the irrational differentials based on the cylinder sizes of different locomotives, but, broadly speaking, he is actually engaged in firing but about 10 per cent of his time and the intervals of rest are frequent and often long. No officer feels that an employee in any class of service should be expected to perform service which will require excessive physical effort, but certainly no such claim can be maintained

FIG. 64.—DISTRIBUTION OF TIME OF CREW OF FREIGHT TRAIN.

	Engineman	Fireman	Conductor	Flagman	Head Brakeman
Getting train ready and putting it away	1hr. 42′	1hr. 42′ Firing	31′	1hr. 03′	1hr. 07′
Getting numbers, seal records, checking bills and making train reports			1hr. 46′	33′ (Helping conductor with reports, etc.)	46″ (Cutting off engine to get coal and water)
Signals			23′	1hr. 35′ (Signals and flagging)	37′
Observing signals and operating locomotive	6hr. 24′				
Looking train over, fixing drawheads, etc.			34′	38′	
Picking up and setting off cars			26′	22′	30′
Miscellaneous duties, orders, registering, etc.	42′	42′ (Miscellaneous)	46′	32′	46′
Total time engaged in actual work	8hr. 48′	2hr. 24′	4hr. 46′	4hr. 43′	3hr. 46′
Total time not engaged in actual work	3hr. 28′	6hr. 24′ On road 6hr. 24′ In terminals 2hr. 48′ 9hr. 12′	6hr. 07′	5hr. 50′	6hr. 47′
Per cent	28.8	88.0	5.79	55.3	64.3
Total time on duty and paid for	11hr. 36′	11hr. 36′	10hr. 33′	10hr. 33′	10hr. 33′

in the case of the fireman. He will lift perhaps, in severe service, 15 tons of coal two and a half feet or 75 thousand foot pounds; if he did it in one second he would exert about two and one-quarter horsepower, but he spreads the effort over 8640 seconds as indicated by Figure 64, and so expends no more than .0263 of one horsepower. As Professor Ramsay estimates a man's power effort at .0400 of one horsepower, the particular effort put forth in firing (263 out of a possible 400), would seem easily within his power. As a matter of fact this is one of those cases of sentimental by-play that make human relations so difficult. A small-cylindered engine working on a low grade line may call for a much larger supply of fuel than one of much larger cylinders working on a line with undulating grades and a heavy ruling grade. When the Pennsylvania Railroad, in 1885, introduced their Class "R" (cylinders 20″×24″) locomotive, they thought to popularize it by paying the men firing it an additional 10 cents per trip and sowed the seed of a vast crop of troubles. Not the least irritating is the hypocrisy of the contention. On the coal burning roads, the demand was made on the claim that the work is much increased by the increase in the size of the locomotive, but on roads using fuel oil the ground was shifted to the contention that a fireman is a fireman and what road "A" paid road "B" should pay. The war has brought pretty much everything into question and this, like many other features of railroading, is not likely to escape the all-embracing spirit of criticism and transformation. Fatigue is an unavoidable phenomenon of man's physiological organism. It is futile and harmful to attribute the feeling of tiredness at the end of the day to work alone. A candid observation will often disclose quite as much fatigue on Sunday or holiday nights as on the nights following the day's work. We should look at questions of this character with sympathy, it is true, but with searching and candid eyes. The entailed consequences are too serious to permit of their disposition in a flood of mushy sentimentality.

Good men who have become acquainted with their duties and who perform them faithfully are among the most im-

portant elements in the organization. It is greatly in the interest of every railroad to retain them and make their work attractive. The condition of the crew of the train is apt to be forlorn when away from home. A company can make few better investments than in proper provision for washing and bathing, for sleeping and eating in comfort, and a lounging room where men can pass the dreary hours of waiting with reading or games. When I was made superintendent the division had a reading room association open to all employees, at an annual fee of one dollar. The library contained some 2000 volumes and covered the range of literature—science, economics, mechanics, railroads being well represented, though the major part was fiction. It was poorly patronized and has since been closed. It is a mistake to offer men much in this way; they do not want it and the exceptional man who would profit by it will seek it out for himself. What the men are greatly interested in is their reasonable bodily comfort, continuity of employment, and protection for their families against the major hazards of illness, accident, superannuation and death, and we should be wise to concentrate on measures to secure these for them.

221. Yard Crew.—In the early days when cars were small and light, horses were used in the yards to switch cars. When the yard locomotive began to come into general use in the late 1870's to take the place of horses, it was popularly known as the "pony engine."

Handling the yard engine does not differ so materially from that of the road engine as to call for special notice, except in the work of the engineman. Almost as much of his time is employed in looking back as in looking ahead. He is much engaged in handling his reverse lever and, if expert at his work, he brings his engine or draft of cars at a fair rate of speed up to the point where it is necessary to check in order that the coupling may be made without damage to the equipment. While doing work around car repair tracks he should keep a lookout for men using push-cars, and for blocks, jacks and material on the track. In placing cars or in coupling cars on the repair tracks or at the shops he should

not make movements without a man on the forward end of the cut or car he is moving. He should be cautious while working about freight houses, team tracks and elevators. It is desirable that yard engines be equipped with fire hose.

Where more than one crew is employed, a careful time study should be inaugurated to determine proper provision of facilities and economy of use in locomotives and crews. The engine crew may frequently be changed to advantage at the point where yard crews register on and off. It is cheaper to have the hostler handle the locomotive to the end of the yard than to have the engine crew take it to the round house. A carefully arranged plan of changing engines or engine crews "on the job" will frequently gain three or four hours locomotive service. Switching mileage affects locomotive economy quite as unfavorably as empty mileage does car movement and every care must be exercised to keep it to the minimum. Great care should be taken to avoid the interference of one locomotive with another by keeping them as widely separated as possible. To a much greater extent than in the road service, the interest and opportunity of the engineman, in the proper handling of the business, equal those of the conductor. The position of yard conductor is filled by promotion from yard brakemen after a qualifying examination which, while not so exacting as that of the road conductor, covers every phase of yard-limit operation. His duties are similar to those of the road conductor in his control over his crew, and when using the main track within yard limits he has certain responsibilities of importance.

The yard conductor is in position to do much toward reducing the delay to cars in yards, where so much of their life is now spent, and to speed up the movement of cars to be classified at his terminal, and when moving a car to keep it moving and always in its normal direction. Intelligent foresight on his part will reduce the yard handling of cars to a minimum and, in times of heavy traffic, he can greatly aid in increasing yard capacity. It also falls to his lot to do his best to satisfy the local shippers and consignees with whom he is in daily contact.

The resourceful yard conductor is a boon to the yardmaster who, relieved of many details he can trust to such a conductor, can devote much of his time to the larger responsibilities of his position.

The yard conductor must see that all cars have good brakes. If a car is found without brakes it can usually be moved in cuts with cars properly equipped and placed at the end of a track easy of access. He must look after the weighing of cars, place refrigerator cars for icing, stock cars at the stock pens, and cars to be cleaned on the refuse tracks. In hump switching he cuts the cars and signals to his brakemen the tracks they are to be let in on. He should first see that there is room in the classification yard for the train that is to be switched. When the yard lighting is poor, red lanterns should be used to let riders know where cars stand and these should be moved as each cut is set. He must know how many cars each track will hold and how many it contains, so that he may make sure that cars are not pushed out on the ladder. When there is danger of main or running tracks being fouled by cars buckling or running out, hump riders should use white lights and be prepared to stop trains or engines at any time. In pushing a long string of cars over the hump he must watch that old, light cars are not roughly handled.

The yard conductor cutting the cars should have his switch list, which is made out by the yard office force from the waybills and car checkers' lists, marked to indicate what the cars contain, and when making the cut should advise the brakeman of the cars containing heavy loading, such as iron ore, moulding sand, etc. He should caution the brakeman in riding cars of explosives or live stock and should not cut cars with such lading without knowing that there is plenty of room to receive them on the tracks to which they are destined. He should make sure that they are ridden by a sufficient number of men to handle them properly, and should give particular attention to their brakes before making the cut. Nor should he make a cut to follow until such cars are safely in their proper classification track.

If the classification tracks get clogged by cars stopping

short, the conductor should put sufficient riders on the cuts to keep them under control and avoid damage to equipment, and this is particularly true of steel cars in cold weather which, if allowed to strike too hard, are likely to break the train line.

In cold weather when cars do not run well, care should be exercised to see that cars clear the frogs and do not foul the clearances. Under these conditions the use, for a few days, of a poling car is ordinarily preferable to raising the hump. When rails are slippery from rain, the conductor should work in close touch with the switch tender to head cuts of cars that cannot be held by the riders into a track known to have plenty of space in which to bring them to a stop. At the end of the day's work the yard conductor hands in his switching list to the yard office for the completion of its records, having marked opposite each car number the identification number of the car rider.

The yardmaster gives the numbers and initials of the cars to the yard conductors who make them up for the outgoing trains, the cars for the first destination going next to the locomotive, and so on, in order that they may be set off with the least switching.

The yard brakemen take their orders from the conductors. Their chief duties are to line up the switches (where they are not handled from a tower or by switch-tenders), to ride the cars into the various tracks, using the hand brakes if necessary to prevent damage when stopping or coupling, and to transmit signals to the engineman. They must make sure that cars are securely placed, but in the classification yards brakes should not be set, save on a sufficient number of cars on the heel, or far end, of tracks to prevent cars from being pushed out and fouling the ladder tracks. If the brakes on the rest of the cars are left off and the brake chains loose, the cars can be pulled out for road dispatch with a minimum of delay. On all yard crews at least one brakeman must be qualified to act as flagman. His qualifying examination consists of written and oral questions. The hazards of the occupation, while immensely lessened by the introduc-

tion of the automatic coupler, better design of yards, greater spread of tracks, and other ameliorating conditions, are still much greater than that of the road service. The men are under constant exposure to the weather and when busy are constantly on their feet. As compared with the crew of the road train, however, the yard crew has the advantage of regular hours and of never being away from home. In the old days the Switchmen's Union undertook to limit its membership in their work to the gait of a walk, and the expression, still frequently heard, "he runs when he walks," arose at that time.

In 1890 the Switchmen's Union of North America began agitating for an increase in yard wages in the Pittsburgh district. In order to obtain a complete monopoly of the field, they took into their organization both the yard conductors and the yard brakemen; proposed a change in their titles to yard foremen and yard helpers. The so-called "Chicago Scale" had made the pay of both grades so nearly alike as to join them in a common interest. The situation threatening to become serious, the late E. B. Wall and I were brought to Pittsburgh and put in charge of the work of installing in all the Pennsylvania yards suitable provision for housing and feeding the new men brought in to fill vacancies should a strike occur, and establishing the police force necessary to protect them. In those days certain politicians in office shirked their sworn duty of protecting persons and property, and virtually gave strikers a quasi-license to commit crime, interfering, if at all, only to embarrass and endanger the company's men.

The work took us into all the yards, required a careful study of each and gave ample opportunity for talking with the men. We were also asked to attend the officers' conference at which the situation was canvassed. Feeling both that the men were entitled to an increase in pay and that the companies must have an organization of their business that would give control and economy in working, I formulated and secured the adoption of what came to be known as the "Pittsburgh Scale," the distinguishing characteristic of

which was a spread between the pay of the yard conductors and yard brakemen sufficient to reflect the difference in rank, responsibility and authority. This scale, modified to reflect the difference in cost of living and character of yard work in the various terminals, by division into three groups, was rapidly spread over all the Pennsylvania yards in Central Traffic Association Territory and was maintained side by side with the "Chicago Scale" until 1904, when uniformity of pay was adopted over the entire region.

The yard work to-day remains the weakest spot in railroad operation because the pay of the foreman is not sufficiently above that of the helpers to make the supervising position attractive. Failure to reflect in differentials of pay the wide range of intelligence, skill and character is costly to railroads and industry alike.

Yard blockades are among the most trying of transportation experiences. When they occur the movement should be carefully controlled and trains not allowed to enter yards to the further embarrassment of the yard men, and to increase the delays to the movement. At such times when the traders as well as the officers of other departments clamor for consideration, self-control and firmness on the part of all from the general manager down are prime necessities. Then it is that a good yard organization is of the greatest help.

Switching cars into district and station order is extremely complicated and costly. To do it efficiently and economically has perhaps engaged more thought and attention than any other problem of management, and to-day, notwithstanding great progress, there is much left to be desired. The conductors, brakemen, switchtenders, seal recorders, callers and clerks and their associates are in the main very resourceful, but with the best intentions they must rely upon the immediate head to take the lead.

Nowhere in the world is there a larger or more important business than that of handling freight transportation. Nowhere in freight transportation better than here can the rule of the lawn tennis player be followed, "accuracy first, then put on your speed," though this will be found to apply

to almost everything in freight movement. Before you start anything it is well to make sure where you will finish.

222. Wages.—The use of statistics in wage relations is very difficult owing to their failure to disclose the existence of "third factors," often of commanding influence. All statements are based on the unit of the dollar; but of this we use two kinds. The gold dollar is of a certain standard of weight and fineness and, as a measure of value, may be thought of as remaining a constant. There have been times, however, when the paper dollar was not redeemable in gold and acquired a value of its own that fluctuated widely. It is obvious that, under such circumstances, the relation between the amount of a particular payment for a service rendered and that which would have been paid had gold coin continued to be the measure of value cannot be fixed with certainty. No figures of wages embracing any part of the period from December 30, 1861, to January 1, 1879, can be used intelligently that do not give due effect to this "third factor." Owing to changes in the volume of gold output, in conditions and volume of production, in the relations of demand and supply of labor, wide fluctuations take place in the cost of living as expressed in the unit of the gold dollar. What the employee can do with his money, the purchasing power of the dollar, the "cost of living" as so measured, the "real earnings," is a "third factor" that must be given due effect. Another "third factor" is the change in the requirements that the circumstance of the time makes upon the wage earner, the so-called "standard of living"; so, that the relation of the dollar unit to the use to which he desires to put it, has undergone constant, unremitting and large changes. Still another "third factor" is the arbitraries or "featherbed" allowances that have attached to the wage. The payment, not for the naked service, but for the service as performed under certain arbitrary divisions; of time, as in punitive overtime; or in space as between work done in or beyond the yard limits; or in character as in doubling the hill; and these in very great number and variety. Any failure to read accurately these and other "third factors" into

wage statistics is fatal to the soundness of the conclusions drawn therefrom.

223. Early Conditions–1828–1839–1850–1863.—Reference to early statistics are of interest rather than of present value.

In 1828 the Stockton & Darlington Railway paid the driver for his services, with those of a horse which he furnished, 0.95 cent per ton of coal per mile hauled, and this included bringing back the empty cars. They paid the locomotive engineman 0.48 cent per ton per mile and out of that he paid his fireman and any assistants, and found at his own cost locomotive fuel, coal, oil, tallow, hemp, and oil for the wagons.

The eight horsepower locomotive then in use ran at a customary speed of three and a third miles per hour and hauled $41^1/_3$ net tons. The cost to the railroad company of finding and repairing the locomotive was estimated at 0.24 cent per mile run.

In figuring on the economy of their wage scale, the officers found that increased speed made such demands upon the muscular exertion of the horse that to run it up from two and a half miles per hour to six miles increased the cost three times, and that to run it up to ten miles per hour increased the cost six times. Their conclusion was that horsepower for heavy goods at high speeds was quite out of the question. In the steam locomotive, while the costs increased with the speed, the increased expense was by no means proportionate to the load. If at a speed of three and one-third miles per hour the expense per ton mile was equal to three, at eight miles it would be equal to about four, the tonnage rating having been reduced from $41^1/_3$ tons to $13^1/_5$ tons.

Lieutenant Lecount, writing in 1839, gives the wages on the Liverpool & Manchester Railway for enginemen at $5.25 per week, the fireman's pay being one-half the engineman's. The men made 90 miles per day, consisting of one round trip and one straight trip; that is, they covered the road both ways three times every two days and had one lay-over away from home.

Zerah Colburn, writing in 1850, puts the wages of a first-class passenger engineman, running one hundred miles a day for one year, at $720. Assuming 3000 miles per month, this would make the rate of pay 2.4 cents per mile. The men had assigned locomotives, and the average mileage of six of the Fitchburg locomotives for the year 1849 was 23,546 miles, or 78.5 miles per day, but when the locomotive was in shop they did mechanic's work on it.

In March, 1863, the Pittsburgh, Fort Wayne & Chicago Railway issued the following "Rules for conducting the running of engines on the Pittsburgh, Fort Wayne & Chicago Railway":

Each driver will run the engine put in his charge, in all cases, except from ill health, or when the service needed from the engineer shall be greater than the master machinist shall deem proper to require of the regular driver. In such cases, the master machinist will put an extra driver in charge for so much service as may be necessary.

The service of a first class driver for one month, shall be on freight engines, 2600 miles, or as near that as may be, and for passenger engines 3000 miles, per month. If less distance is made in any month, a proportionate deduction will be made from monthly wages. But, in cases where the necessities of the service of engines require it, the master machinist may require extra running, not exceeding 200 miles on freight, or 300 miles on passenger engines in any one month. The master machinist may modify the amount of the monthly work, when peculiar circumstances make the labor more difficult than the average running on the railway, to the extent of 10 per cent reduction of running distance, to equalize the labor on more difficult and different sections of the railway.

The duty of a second class driver on freight will be 2400, and on passenger trains 2600 miles per month, with such amount of extra running as the master machinist may direct.

The duty of a third class driver, will be regulated by the master machinist.

The wages to be paid per calendar month shall be as follows:

First class drivers	$75
Second class drivers	65
Third class drivers	60

No extra time will be allowed.

The division superintendent will decide as to the necessity of extra use of engines, and under his order, the master machinist must provide for such extra service. If such extra service be in the judgment of the master machinist greater than should be required of the regular driver, then the master machinist must put an extra driver in charge for so much duty as he may consider necessary, the same as would be required if the regular driver were sick.

The wages above set forth, to be from the first of March, 1863.

The master machinist will regulate the duty and pay of drivers not entitled to third class service.

Pittsburgh, March, 1863.

JOHN B. JERVIS,
General Superintendent.

The respective superintendents of division will take the necessary measures to carry out the preceding regulations.

JOHN B. JERVIS,
General Superintendent.

Pittsburgh, Pa., March 23, 1863.

H. A. GARDNER, ESQ.,
Superintendent Western Division.

DEAR SIR:

To render my instructions of the early part of this month, in relation to the compensation and duty of enginemen, more specific, you will modify as to duty and compensations, as follows:

On Division C

On freights, a month's work will be 18 single trips.
On passenger, a month's work will be 22 single trips.

On Division D

On freights, a month's work will be 16 single trips.
On passenger, a month's work will be 20 single trips.

Compensation of 1st class enginemen	$75	per month
Compensation of 2d class enginemen	70	per month
Compensation of 3d class enginemen	55	per month

Very respectfully yours,

JNO. B. JERVIS,
General Superintendent.

A. BRADLEY, ESQ.,
Superintendent Eastern Division.

DEAR SIR:

My instructions of the early part of this month, relating to compensation and duty of enginemen, in conform to trips, as re-

quested by Engineman Sully and others, you will modify as follows:
Pittsburgh to or from Alliance as follows:[1]

Enginemen, on coal burners on freight	$2.85	per single trip.
Enginemen, on wood burners on freight	2.70	per single trip.
Enginemen, on passenger trains........	2.50	per single trip.

Alliance to or from Crestline, as follows:

Enginemen on freight-coal burners....	$3.00	per single trip.
Enginemen on freight-wood burners....	2.85	per single trip.
Enginemen on passenger trains........	2.70	per single trip.

Shifting or switching, Crestline & Alliance, $2.50 per day.

Very respectfully yours,

JNO. B. JERVIS,
General Superintendent.

The rates of pay fixed in 1863, remained constant until 1872 when they were reduced 10 per cent owing to business depression. There was a strike for a few days but this had no effect in impeding the change.

The question of wages frequently develops into the controversial stage during times of business depression and falling revenues, when forces are being reduced, and during times of business activity, when labor is in great demand and the cost of living advancing.

A brief review of the wage variations since that time may be of interest, and it will be more exact if I deal principally with changes coming within my own experience. Because of limitation of space I have dealt only with the wages of enginemen, which are fairly illustrative.[2]

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[1] The distances were:

Pittsburgh to Alliance................	83 miles
Alliance to Crestline..................	106 "
Crestline to Fort Wayne.............	132 "
Fort Wayne to Chicago..............	148 "

[2] A search of the files of various publications indicate that formal agreements between the organizations and the railroads were first entered into as follows:

Brotherhood of Locomotive Engineers:

The first schedule was negotiated on what was then known as the Gould Southwest System, which included the Missouri Pacific, Missouri, Kansas & Texas, Central Branch of the Union Pacific, St. Louis, Iron

224. *Demand of 1888.*—Demands were made in January, 1888, for increase in pay. Mr. McCrea was most anxious to meet every reasonable suggestion and several weeks were spent in discussion. A comparison of through freight rates showed that on 21 runs, averaging 100 miles in length, the average rate was 2.72 cents per mile, with a maximum of 3.20 cents on a run of 91 miles, and a minimum of 2.48 cents on a run of 143 miles. An engineman from Fort Wayne, having, during the course of the discussion, stated that the men would be entirely satisfied with rates that would enable them to earn 100 dollars per month, all the runs were canvassed with a view to this result, and a pay schedule put in effect on February 25, 1888, that worked out generally for the through freight enginemen as follows:

Miles Inclusive	Cents Per Mile
80 to 89	3.0
90 to 99	2.9
100 to 109	2.8
110 to 119	2.7
120 to 129	2.6
130 and over	2.5

This rearrangement of rates resulted in increasing annual compensation 3.62 per cent. An allowance for overtime was for the first time established, and in exact accordance with the suggestion of the representatives of the men. It was payable after a time for the run determined at 10 miles per hour

Mountain & Southern, Texas & Pacific, and the International & Great Northern. This schedule took effect October 1, 1882.

Brotherhood of Locomotive Firemen & Enginemen:

The first schedule was negotiated on the New Jersey Central R. R., now known as Central R. R. of New Jersey, and became effective February 1, 1887.

Order of Railway Conductors:

At least as early as 1890.

Brotherhood of Railroad Trainmen:

Record indefinite, except that a "memorandum" agreement was made on the Missouri Pacific R. R. in 1889 by the Brotherhood of R. R. Brakemen and Brotherhood of Railroad Conductors.

Order of Railroad Telegraphers:

During the year 1893 the first agreement was made on the Atlantic & Pacific R. R., now known as the Gulf, Colorado & Santa Fe R. R.

to the nearest half-hour, and was made uniform for all through and local freight trains for:

	Cents Per Hour
Enginemen	31
Firemen	17
Conductors	23
Brakemen	15

The claim was made that heavier engines and longer trains had resulted in increase of risk and liability to injury of the men. A careful review of the records of the Claim Department showed that the percentage of personal injuries to men in the freight service, on divisions using heavy engines, was smaller than where light engines were used.

225. *Demand of 1891.*—In January, 1891, there was submitted to the Pennsylvania Lines a "schedule of wages" consisting of 168 articles relative to rates of pay, payment of overtime, discipline of employees, and the adjustment of minor matters. The company, after painstaking consideration, declined to substitute a rate per mile for its practice of paying by the trip saying "the company has adjusted the wages so that the men employed on the short runs that are necessary for the conduct of the company's business and the accommodation of the public, will be able to earn such money as compares favorably, all circumstances considered, with the men on the longer runs of the usual train schedules; therefore the company believes that the present basis is the proper one, and one that is very much more equitable and just to its employees than any yet proposed. The rates have been fixed after a careful consideration of the length, time required, and amount of work to be done on each particular run; nor would it appear that it is sought by the men that this method should be altogether abandoned. The committee, in asking to have all trips of less than 60 miles rated at 60 miles, all trips between 60 and 100 miles rated at 100, and all trips over 100 miles rated at the actual mileage, and that circus trains and other extra service be given a constructive mileage of 150 miles, have made a rough division, which cannot be

so fair to the men or to the company as the present careful method." In response to the request for an increase in wages estimated to amount to 27 per cent, the company declined to make any advance, saying "it is true that trip rates in some cases are not as high as before the reduction in 1872, but by reason of the increase in second track and passing sidings, extensive yards, the introduction of better methods of signaling and train dispatching, together with the use of the air brake and improvements on the equipment, the movement of trains has been greatly expedited, and the monthly earnings of the men are larger than in 1872, the employees are now earning nearly 10 per cent more than they did in 1872, and in some instances 50 per cent more, with a very marked decrease in the risk, exposure and work."

A comparison with other roads disclosed that the Pennsylvania Lines were unexcelled in the conveniences and appliances adopted for the safety and comfort of the men, and the facility with which they could perform their work while the average monthly earnings of the men were generally greater than those earned on other roads in the same territory. The company declined to undertake to increase the speed of trains as suggested, for it would only be possible because of large investments made by the company in providing greater and improved equipment and facilities; and while the company was constantly endeavoring to make it possible for the employees to earn maximum wages with minimum time, it could not be admitted that, when the company, by these large expenditures, had reduced the cost of transportation, all such saving should be absorbed by its employees in the shape of increased allowances. An increase in the rate of overtime pay was declined, the adjustment of 1888 having been found to have been too liberal and a heavy burden to the company. It was felt that it encouraged the creation of overtime, and that it was not beneficial, either to the company or the employees, to make delay in operation a premium to those in charge of trains. The proposition was not for a reduction in the hours of labor, but an increase in compensation. Further, no advantage accrued to the company in cases where

the men were on the road less than the maximum time. The company pointed out that while it had always sought to have the most pleasant and cordial relations existing between it and its employees, the responsibilities were reciprocal, while the company was in addition under heavy responsibility to the commonwealth, to its shareholders and to the communities through which its lines passed. It said "the law places upon the directors of the company the responsibility of the performance of these various duties, and of the management of the railroad property. It does not permit them to delegate these duties to others, or limit by contract the exercise of their wise discretion in the performance of these duties, with which they are charged. No contract or agreement exists between the company and any of its men, except individual contracts entered into at the time of the employment of the men, and the officers cannot enter into any agreement to exclude the exercise of their authority in individual cases, when, in their judgment, the exercise of such authority becomes necessary."

226. *Demand of 1892.*—In October, 1892, the firemen demanded an increase in rates which the General Manager declined to make.

227. *Demand of 1900.*—In January, 1900, demands having been again presented, an extensive and painstaking investigation was undertaken of the rates of pay and monthly earnings of blast furnace, machine shop, and numerous other industrial employments, as well as the rates paid by other railroads throughout the entire country. Nothing was found that was felt to justify any general increase in the rates, but a change was made in the overtime paid road freight crews which was fixed at:

	Cents Per Hour
Enginemen	34
Firemen	19
Conductors	24
Brakemen	17

228. *Advance of 1902.*—The close of the Spanish-American War coincided with the end of the period of adjustment

following the panic of 1893, and business experienced a general and rapid revival and expansion. This was accompanied by a general rise in prices from the low of 1896. The Pennsylvania Railroad, appreciating the general conditions, the exceptional demands upon the employees growing out of the largely increased traffic, and the increased cost of living to the employees, increased the pay 10 per cent, effective on November 1, 1902.

229. *Advance of 1906.*—The Pennsylvania Railroad made a further advance of 10 per cent in wages of all employees receiving less than $200 a month, effective on December 1, 1906, being moved thereto by the considerations announced in 1902.

230. *Sixteen-Hour Law.*—The men in the train service had secured the enactment by Congress, effective on March 4, 1908, of a law limiting the working hours of trainmen to continuous periods of 16 hours and providing for intervals of rest of eight hours, and some of the states had enacted legislation of similar character. As a consequence, where possible, the location of terminals was rearranged to avoid tying up crews on the road. Efforts were made to equalize the rest periods of crews formerly taking a short rest at the home end of their runs and a long one when away from home. The increase of time spent at terminals could not be altogether avoided; some additional crews had to be employed. There were numerous cases where the average income of freight crews was reduced, and the expense per train mile to the companies increased.

The dislocation of established practices was severe and an agreement was reached at Chicago on April 19, 1908, between the general managers of 32 western railroads and the representatives of the four brotherhoods, establishing what came to be known as the "fourteen-hour rule," and providing generally for modification of existing schedules or agreements in accordance with the new conditions.

231. *Wage Movements on B. & O., N. Y. C., et al., of 1910.*—The 1910 wage movements were begun by the conductors and trainmen who had formed an association known as the

Eastern Association of General Committees of the Order of Railway Conductors and Brotherhood of Railroad Trainmen.

Late in December, 1909, the management of each of the Eastern railroads was presented with a proposition from these employees for the adoption of revised rates of pay and certain rules governing working conditions, with the request that answers be given on January 20, 1910. At the same time the presidents of the two organizations communicated with the managements of the railroads for the purpose of ascertaining whether they would prefer to conduct the negotiations collectively for all the railroads or individually. The managements decided to negotiate individually.

Thereupon the Baltimore & Ohio Railroad Company was selected for opening the negotiations, the reason for such selection being, as stated by the representatives of the employees, that the bases of the Baltimore & Ohio Railroad schedules more nearly corresponded with the revised proposition than the schedules of practically any other Eastern railroad, also that it meant less of an increase for the Baltimore & Ohio Railroad to adopt the proposed rates than any other railroad with perhaps one exception. It early became apparent that the authority to make settlement rested entirely with the representatives of the organizations and that the employees of the individual companies were powerless to make settlements as they had in the past.

The management of the Baltimore & Ohio Railroad was unable to agree with the representatives of the organizations; thereupon the latter appealed to the individual employees who authorized them to declare a strike if satisfactory terms were not agreed upon.

After this was concluded, negotiations were resumed, and, it being found impossible to reach a settlement, the services of the federal mediators under the Erdman Act, which was then in effect, were requested by the President of the Baltimore & Ohio Railroad Company, the representatives of the employees declining to join in the request. At the request of the mediators, Hon. Martin A. Knapp, presiding Judge of the U. S. Commerce Court, and Hon. Chas. P. Neill, U. S.

Commissioner of Labor, the representatives of the employees agreed to conduct negotiations through them, and after negotiations lasting a week or more, terms of settlement were reached upon a basis which was practically a split between the then existing rates and those requested. This settlement, it was carefully calculated at the time, increased the rates of pay 5.44 per cent.

While the mediation proceedings were pending on the Baltimore & Ohio Railroad, negotiations were opened by the two organizations on the Boston and Maine Railroad and the New York, New Haven and Hartford Railroad, on which roads settlements were reached on practically the same basis as had been adopted on the Baltimore & Ohio Railroad.

Negotiations were also begun by the chiefs of the two organizations on the New York Central and Hudson River Railroad. This company was unwilling to adopt the rates agreed upon in the Baltimore & Ohio settlement. The representatives of the organizations took the position that, having agreed to these rates on the Baltimore & Ohio through federal mediation, they could not reasonably agree to any other rates on any other railroad, having declared to both the Baltimore & Ohio officials and the federal mediators that whatever rates were agreed upon for the Baltimore & Ohio Railroad would be established upon the eastern railroads so far as the means at their command could accomplish that result. However, after prolonged negotiations with the New York Central Railroad, they finally agreed to an arbitration of their request as applying to that company, E. E. Clark, a member of the Interstate Commerce Commission and a former President of the Order of Railway Conductors, and P. H. Morrissey, a former President of the Brotherhood of Railroad Trainmen, acting as arbitrators. Some 17 railroad companies had agreed to be bound by the New York Central award, and as soon as the award was announced it was adopted by them.

It was estimated that the settlement on the New York Central Railroad advanced rates 17.4 per cent; on the Cleveland, Cincinnati, Chicago and St. Louis Railway 12.7 per

cent; on the Lake Shore and Michigan Southern Railway 11.92 per cent; on the Michigan Central Railroad 19.8 per cent; on the Boston and Maine Railroad 19.6 per cent; and the New York, New Haven and Hartford Railroad 15 per cent.

Effective on April 1, 1910, the Pennsylvania Lines East granted to all their employees, including conductors and trainmen, a flat increase of six per cent, with the exception of yardmen, who received an increase of 8.4 per cent, the percentage for both road and yardmen equaling approximately seven per cent. The Pennsylvania Lines East had two bases of pay for enginemen and trainmen, commonly known as a high rate day applying to runs of over 100 miles with overtime after 12 hours, and a low rate day applying to runs of less than 100 miles with overtime after 11 hours. These rates were not uniformly applied, but their application varied by the trip according to the class of service, that is, whether through or local, and according to the conditions on the several divisions. The adjustment of six per cent placed their runs on practically the same basis as the rates granted in both the Baltimore & Ohio settlement and the New York Central award, but on account of the overtime limits which they previously enjoyed the employees considered they would not fare so well compared with other neighboring lines as they had formerly; also the yard rates awarded in the New York Central arbitration were higher than the rates the Pennsylvania Lines were paying, including the six per cent increase. The employees declined to accept this settlement, and on July 14 negotiations were broken off, the men notifying the company that they would leave the service within 48 hours. Several days later, it being apparent that there was a lack of understanding, conferences were resumed and further adjustments made effective from June 1, 1910, through which additional increases amounting to 4.4 per cent in road service and 6.9 per cent in yard service were granted. These coupled with the previous adjustments produced an increase of 12.35 per cent for the conductors and trainmen on the Pennsylvania Lines East. The settlement made on

the Pennsylvania Lines West, at approximately the same time, resulted in an increase of 12.37 per cent.

Previous to this time there had been no definite relation between the rates of pay of engineers, firemen, conductors and trainmen, for a great many years, as one class of employees had been increased, the other classes were correspondingly increased. The managements of the eastern lines received requests from their engineers and firemen for adjustments of their rates of pay and working conditions while the negotiations were pending with the conductors and trainmen, and settlements were made by these companies with the representatives of these employees very largely in line with the increases granted the conductors and trainmen. For instance:

On the Baltimore & Ohio Railroad, effective on April 1, 1910, the engineers received increases amounting to 8.03 per cent; firemen 9.04 per cent.

Pennsylvania Lines East; engineers, effective on June 1, 12 per cent; firemen, effective on April 1 and June 1, 9.6 per cent.

New York Central and Hudson River Railroad; engineers, effective on May 1, 8.93 per cent; firemen, effective on May 1, 9.8 per cent.

Lake Shore and Michigan Southern; engineers, effective on June 1, 8.6 per cent; firemen, effective on May 1, 7 per cent.

Michigan Central; engineers, effective on September 1, 16.4 per cent; firemen, effective on May 1, 16.93 per cent.

Cleveland, Cincinnati, Chicago and St. Louis; engineers, effective on April 1, 11 per cent; firemen, effective on June 1, 5.3 per cent.

At this time, the railroads also generally increased other classes of employees to greater or less extent. For illustration:

On the Baltimore & Ohio Railroad all employees receiving less than $212 per month were increased six per cent, effective on April 1, 1910.

On the Pennsylvania System all employees receiving less than $300 per month received an increase of six per cent, effective on April 1, 1910.

On the New York Central and Boston and Albany Railroads all employees receiving less than $200 per month received an increase

of seven per cent, excepting employees whose wages had been increased on January 1, 1910.

In their award, rendered on May 14, 1910, the arbitrators, voicing largely the hopes of the organizations, said "we recognize the importance and desirability of the closest possible approach to uniformity of pay of employees in service in a given territory, but the closest approach to such uniformity has always recognized some variations on account of differing conditions on different lines of railroad."

232. *Effect of the Award of May 14, 1910.*—The significant result of this proceeding, therefore, was a very great step towards standardization both in rates of pay and in rules of service throughout the Eastern Territory. Substantially all the railroads in the Eastern Territory which had not already reached agreements with the conductors and trainmen accepted the award in the New York Central case.

In the increased pay adjustments growing out of the movement of 1910, 43 roads made increases effective from April to December; seven roads made increases in 1911 running from January to August, and two made increases in January, 1912. For all the 52 roads in the Eastern region the annual increase in the wages of locomotive engineers was $4,044,230.73, or 10.84 per cent, the increases ranging from four per cent, where the increase was least, to 20.3 per cent where the increase was greatest.

In 1911 the conductors received an increase in pay of $7,042,439 and this was an increase in the rate of pay of 32 per cent over that received in 1900.

The enginemen's payrolls of the Eastern region for 1911 indicated that on the basis of the 1910 settlement there was an increase over 1910 of 7.7 per cent, over 1909 of 9.7 per cent, over 1908 of 10 per cent, over 1907 of 13.5 per cent and over 1900 of 30.7 per cent. The actual compensation paid enginemen in 1911 was $41,874,264.

In the twelve years the railroad companies paid 68 per cent more for engineers' wages, of which 30.7 per cent was due to increased rates of pay and 37.3 per cent to increased number of employees. With the exceptions of increases

granted to certain occupations and in some cases certain classes of service, the rates established in 1910 continued until the engineers' arbitration in the year 1912.

In the controversy with the Coal & Coke Railroad, Stone, testifying for the engineers, said that in making a schedule they would not give consideration to density of traffic, the number of trains run, the kind of business, the size of engines and that kind of thing. The engineer would work just as hard if there was only one engine on the road as if it had a thousand, and he gives his time, which is his whole stock in trade and is all he has to sell.

Within the period 1910–1912 the engineer had been relieved of:

Inspection of frame underneath.
Filling grease cups.
Adjusting wedges.
Packing leaking joints.
Cleaning and caring for head and classification lamps.
Placing and disposal of tools on engines.
Taking coal, water and sand.
Cleaning engine.

233. Engineers' Arbitration, Eastern Territory, 1912.— In January, 1912, the Brotherhood of Locomotive Engineers formulated requests for standard rates of pay and working conditions for all lines in the Eastern region. Its representatives met a committee of 12 officers of the 52 roads involved on March 14, and hearings extended over that and the following day. Adjournment was then had until the 25th when the managers replied, denying the requests as a whole. Arbitration was then arranged by Messrs. Knapp and Neill, acting as mediators under the Erdman Act, and began on July 15, before a Board of Arbitration composed of

Honorable Oscar S. Strauss, Chairman,
Dr. Charles R. Van Hise,
Frank N. Judson,
Dr. Albert Shaw,
Otto M. Eidlitz,
Daniel Willard, representing the railroads,
P. H. Morrissey, representing the Brotherhood of Locomotive Engineers.

Hearings were opened by a statement of the case for the engineers by Warren S. Stone, Grand Chief, and for the railroads by B. A. Worthington, Receiver of the Wheeling & Lake Erie Railway. Twenty-five witnesses were offered on the part of the engineers and 16 witnesses by the railroads. Over 80 exhibits, statistical tables, diagrams and explanatory statements were offered by Stone, and over 130 by the railroads. At the close of the testimony the case was summed up, and, following the oral presentation, briefs were submitted and from September 9 to September 14, inclusive, the board met to take up the question of findings and reconvened from October 28 to November 2. Its decision when handed down was made retroactive to May 1, 1912, and effected an annual increase in engineers' wages on the interested roads of $1,600,000, or four per cent.

The position of the engineers was that they did not base their claims for increased compensation wholly on the increased cost of living, as so many do, for two reasons; one was that the cost of living is largely a question of the standard of living and that the question of mere existence is something which each individual must decide for himself; the other reason was that there were many elements that enter into the fixing of the rate of wage for an engineer that must in all fairness be given further consideration. Their requests were rather based upon responsibility, skill and efficiency required, and the hazards of the profession. Stone protested that every man, regardless of what might be said to the contrary, every engineer who calls himself such, takes pride in his work and shows a loyalty to the company that cannot be purchased. He stated that the organization was opposed to pension systems because (1) they were responsible for a stricter physical examination and (2) because they are another way of binding the men closer to the company. In answer to the question as to where the money was to come from Stone answered "eventually it has got to come from the man who pays the freight bill."

The engineers demanded changes in rules of service affecting:

1. Beginning and ending of day.
2. Initial terminal delay.
3. Final terminal delay.
4. Time held away from home terminal.
5. Application of sixteen-hour law.

The grounds on which the demands were ultimately based were:

1. Increased responsibility and risk due to:
   (a) Increased speed of trains.
   (b) Increased number of block signals.
2. Increased labor due to:
   (a) Increased train loads.
   (b) Increased size of engines.
3. Increased value of services due to increased train loads.
4. Increased requirements of men due to:
   (a) Stricter physical examination of applicants.
   (b) Stricter discipline.
   (c) Longer hours of continuous service.
5. Resulting in:
   (a) Decreased vitality of engineers.
   (b) Restriction of working period.
6. Last increase in pay not commensurate with increase in other classes of employees, the latter amounting to 20 per cent to 24 per cent, while enginemen received no more than 6 per cent to 10 per cent.
7. The pay of engineers is low as compared with the pay of engineers in the Western and Southern regions.
8. The pay is low when it is considered that the working conditions in the Western and Southern regions, where such higher rates prevail, are better than in the Eastern region.
9. Since the last advance there have been changes in working conditions such as required the men to work a full number of hours before overtime commences, so that the men have not received the benefits contemplated by such advances.

The position of the railroads was that since 1910 there had been no increase in risk, responsibility or physical labor of the individual engineman on any one of the 52 roads involved, either on account of the size of the engine, the speed of the train, or the loading of the train.

The total number of enginemen employed was 31,840. Slightly more than one-half, 50.4 per cent, were under 40

years of age; 28.2 per cent between 41 and 50; and 21.4 per cent were over 50 years of age; the average of all being 42 years. The reports of the Interstate Commerce Commission showed enginemen's earnings in 1900 about $1130 per year; 1910 about $1360, and 1911 about $1500. In 1911 the enginemen received $9,801,592 over the wages prevailing in 1900, and this was at the rate of 30.7 per cent. In the same period the train load increased 40.7 per cent, to a total of 480.7 tons. The effect of the demands now made for standardization would be an increase on the roads paying the highest rates of 10.4 per cent, on the roads paying the lowest rates of 56.35 per cent; and the average increase to all enginemen would be 17.71 per cent.

The railroads claimed that the existing wages were fair and liberal, and that

A. Railroad employees are as well or better paid than labor in other employments.

B. The engineers constitute the highest paid class of employees in the railroad service.

C. The existing differential in the rate of pay in favor of the engineers against the conductors growing out of the wage adjustment of 1910 corresponds in the majority of cases with the differential theretofore existing for a number of years in favor of the engineers.

D. The 1910 adjustment of engineers' wages was made except in three or four instances, as shown by table submitted, on the 52 roads involved subsequent to the adjustment with the conductors and trainmen.

E. The engineers have worked under the existing differential for the past two years without protest until the issue raised at this time.

F. There is a presumption in favor of the conclusion that the existing differential between the engineers and conductors is as wide, if not wider, than is warranted by the character of the service rendered by these respective classes of employees in view of the fact that the conductor has always been and is now recognized as the superior officer of the train; also in view of the fact that the existing differential was made at a time when the engineer was required to work for two and three and some times more hours upon his engine before beginning or after the completion of the trip; further, the differential in the Western district, as shown

by graphic chart presented, was much narrower than the differential in the Eastern district at that time.

Counsel for the Conference Committee of Managers, W. M. Duncan, in making this argument claimed that:

Standardization of rates of pay or a minimum rate of pay is a utilization of the old trade union weapon of raising the lower rather than bringing down the pay of the upper classes. The flat rate fails to take into consideration the differences in the service rendered. The rates of pay should be made with reference to the character of the service. The service must be classified and depends largely upon local conditions incident to the various lines. The demand is to pay $7,500,000 annually to the same number of engineers for precisely and identically the same service. The demand is unjustified. There is no foundation for it in the hardships these gentlemen say they undergo, no justification when you compare their wages with other classes of employees either in the railroad service or elsewhere. Railroad labor is as well paid and some better paid than any other class of labor. The engineer is the best paid of the railroad classes. There has been no increase in risks or hazards because of track conditions or density of traffic, no increased responsibility because of increase in size of engines, no increased physical labor or change since 1910. It is the public that pays increases and properly since it receives the benefits. The public consist, in large part, of the people who are making their $700, $800, $900, $1000, $1200 and in some very few cases, like the engineers, $1500 a year. The demand of the engineers puts upon these people a duty of paying in the long run this increase, and, check them up against the character of the service that the engineer performs, compared with the service these people perform, in all this advancing civilization, and I think you can reach no other conclusion but that upon these facts these men are not entitled to any increase in wages.

1. The roads opposed standardization because of dissimilar physical characteristics and traffic conditions on:
   (*a*) Different roads,
   (*b*) Different parts of the same road,
   (*c*) Difference in wages paid labor in other employments in different localities.
   (*d*) Marked variations in earning opportunities:
      (1) Varying operating conditions,
      (2) Varying rates per ton mile,
      (3) Varying volume of traffic. (This last to meet claim of engineers that their services are worth more the larger the load, etc., which varies on different roads.)

2. Standardization is inconsistent with demands that
   (*a*) Existing rates of pay or better working conditions shall not be reduced by the proposed rates or rules. (Mr. Stone afterwards expressed his willingness to withdraw this contention.)
   (*b*) This settlement is not final as matters not specifically covered by it remain matters in dispute.

Mr. Duncan continued: "There is a great deal of branch line mileage on which the train service is rather meager and the demand on the individual is lessened. Standardization of wages fails to consider

1. All railroads not equally able to pay, there being a marked variation in their earning capacity and ability to pay.
2. The economies introduced, which are contributions of management and capital, have had their returns largely absorbed by the employees.

The local freight service possesses a number of advantages not possessed by the through freight. The work is no more arduous in so far as the engineer is concerned and does not warrant an increase of 25 cents per 100 miles."

Mr. Worthington said that for some time past the attitude of representatives of labor has been that "labor is not receiving its full share of the earnings of the railroad companies and that it is for this reason entitled to a larger proportion. Labor now comes to us with a demand for a standard scale of wages regardless of the earning capacity or the local conditions under which the road is operated. It would seem that the first position is opposed to the second as it is clearly manifest that the ability of the railroad to pay must be measured by its ability to earn."

The arbitration board complained that "no principle has been presented by either side upon which the question at issue can be settled," nor did the board itself lay down any principles. It seems to have contented itself with a consideration of the average daily compensation of the engineers and other members of the train crew in the Eastern, Western and Southern regions and for the United States as a whole,

and then to have fixed a minimum rate for freight engineers of $4.75 for 10 hours or less, or 100 miles or less, miles made in excess prorata, overtime in freight service to be computed on the basis of ten miles per hour and pay prorated on a minute basis. Twenty-five cents per 100 miles or less to be added to through freight rates for local freight service, according to class of engine, through freight rates to apply on all work, wreck, pusher or helper, mine runs or roustabout circus trains, and trains established for the exclusive purpose of handling milk, all according to class of engine—these awards, without prejudice to existing higher rates on different classes of engines, were made effective as of May 1, 1912.

Mr. Willard, representing the railroads, signed the report with a statement that he did so "to plainly signify its acceptance by the parties he was chosen to represent. . . . The award is not such as the railroads had hoped for nor is it such as they felt would be justified by a full consideration of all the facts."

Mr. Morrissey, representing the engineers, signed the report with a statement that "the award of the board does not settle, it merely postpones the settlement of the principles for which the engineers are contending. . . . The majority report says 'what, then, is the basis upon which a judgment may be passed as to whether the existing wage scale of the engineers of the Eastern District is fair and reasonable? It seems to the board that the only practical basis is to compare the average daily compensation of engineers in the Eastern District with that of engineers in the Western and Southern Districts and with that of other classes of railroad employees.' " He criticised the statistical information on which the board acted as insufficient, unreliable, inaccurate and misleading, and held that in them "all compensation paid to engineers, whether for mileage, overtime, deadheading, switching and other like allowances within the individual schedule is included in the total amount. All it did or purported to do was to divide the total amount of compensation paid the engineers by the total number of days worked by them to determine the average daily compensation." He held

strongly that "the representatives of no class, even that of the public, should have a majority of the members of the board" and that "to take away from them (the employees) their present industrial defense (the strike) because of their relation to the public service simply with the promise that they would be treated fairly by a wage commission or other tribunal created for the purpose, is wholly inadvisable."

234. Firemen's Arbitration, Eastern Territory, 1912–1913. —The Conference Committee of Managers (seven in number) for the Eastern Region met the officers of the Brotherhood of Locomotive Firemen and Enginemen on September 2, 1912, and after a full discussion declined on December 14 to accept the adjustment demanded and claimed to be based on the engineers' award. The dispute was thereupon submitted to arbitration under the provisions of the Erdman Act which had been amended by Congress to meet the criticisms of Morrissey. The arbitrators were Judge W. L. Chambers, representing the public, W. W. Atterbury, representing the Railroads, and Albert Phillips, representing the Brotherhood of Locomotive Firemen and Enginemen. The Board met on March 10, and began hearings which continued daily, except Sundays, until April 5. Much evidence, including voluminous statistics, was filed by both sides, the whole making three printed volumes of evidence comprising more than 2000 pages and four volumes of printed exhibits comprising perhaps as many more pages. There were also exhaustive briefs of counsel. The finding of the board was filed on April 23, and became effective on May 3, 1913. One important and far-reaching ruling fixed uniform wages for the same classes of service on all roads concerned, but this was not to reduce any rates then in use. A classification of locomotives, for the purpose of fixing wages according to weight on the drivers, was made, ranging from 80,000 to 350,000 pounds, with a special rate for Mallets regardless of weight. The firemen were relieved from cleaning engines. The general practice was brought into harmony with the engineers' award. The increase in rates demanded by the firemen was 36 per cent; the award gave them 9.4 per cent, or about what the

railroads had offered, an estimated annual increase for the roads affected of $2,737,000. The result was not satisfactory to either party and revealed how poorly large-scale arbitration is adapted to the real solution of wage problems. The Newlands Act was shown to be a make-shift precisely as the Erdman Act had been unsatisfactory because constructed upon wrong principles.

235. Conductors and Trainmen Arbitration, Eastern Territory, 1913.—A dispute between the Order of Railway Conductors and the Brotherhood of Railroad Trainmen and the roads in the Eastern Region was submitted to arbitration under the Newlands Act by agreement dated July 26, 1913, the board of arbitration consisting of:

Messrs.	Seth Low, Chairman, John H. Finley	representing the public.
	W. W. Atterbury A. H. Smith	representing the railroads.
	L. E. Sheppard D. L. Cease	representing the brotherhoods.

It was the third concerted wage movement which had gone to arbitration in the Eastern Region within a period of two years. The amounts asked for were estimated at $17,975,688, annually, or an increase of about 21 per cent. The men demanded that they be given the Western rates of pay, while retaining the rules and regulations affecting pay prevailing in the East, for the following reasons:

(*a*) In the name of standardization.
(*b*) On account of increased cost of living.
(*c*) On account of increased risk, labor and responsibility.
(*d*) On account of the increased productivity of the work of a train crew.
(*e*) On the ground that the profits made by the railroads in recent years had increased out of proportion to wages.

The arbitration board found that standardization as to pay and rules, as between the Eastern and Western territories, was at that time impossible; that there had been a sub-

stantial increase in the cost of living since the adjustments of 1910, amounting to at least seven per cent; that the elements of risk and labor growing out of increased size of trains and cars were practically offset by the substitution of steel for wood in the construction of cars and by the various safety appliances that had been installed; that the extra productivity of the train comes from the increased number of locomotives, in connection with each of which an engine crew is paid for, and not to any measurable extent from any contribution to extra productivity by the train crew itself; that it was unable to relate the facts as to profits to the question of wages in such a way as to found thereon specific increases in rates of pay. The arbitration board went on further to express the opinion that punitive overtime, so-called, is an unsound principle when applied to the running of trains. It adopted the views of Messrs. Clark and Morrissey that the theory underlying a mileage schedule of pay is that the employee will be paid for all the service he renders and the company will not pay for any service that it does not get; that, unlike men in ordinary industrial trades, employees on trains must, in order to enjoy the advantages of home life, have their runs so adjusted as to give them the greatest practicable amount of time at home; and that, on the other hand, the exigencies of the business are such that the responsible managing officers of the road must have reasonable leeway within which to adjust the number and time of their trains, and the points between which they will run, in such way as best and most satisfactorily to serve the public. The train men have only their time and their labor to sell, and the arbitration board felt it to be fair that they should receive remuneration for the time they place at the disposal of the railroad as well as for the labor they expend in its service. The effort to adjust these two elements harmoniously between the railroads and their employees the board hoped would be carried somewhat nearer to a satisfactory solution by the results of the arbitration. Neither side should be content until rules have been mutually agreed upon which were fair both to the railroads and to their employees in all respects.

The attention of the arbitration board was called to certain low spots in pay but it declined to remove them since it was prevented under the terms of the submission from removing the high spots.

It was the prevailing opinion of the arbitration board that, taken all together, the changes in conditions since 1910 affecting rates of pay fully justified an increase in rates of pay in a total of 6.1 per cent, which it was estimated would involve an additional expense to the railroads in the Eastern region of $5,237,233 and carry the rates to the approximate level of the rates then in force throughout the Southern territory, east of the Mississippi. It expressed itself as having had to be content with dealing with facts as they were and expressed no opinion as to the justice of the wage scale.

To the opinion Messrs. Atterbury and Smith dissented because:

1. Standardization is chimerical and uneconomical.
2. Such increased cost of living as has occurred is not sufficient to justify the increase granted.
3. Statistics prove that risk has decreased; that hours of work have decreased; the weight of evidence is that labor has not increased; and we cannot agree that it has been proven that anything so intangible as responsibility has been increased.
4. The conductors and trainmen are but one of the many factors in efficient railroad operation, and are no more responsible for increased productivity than any other class of railway labor.

They expressed the fear that "the result of this arbitration cannot but further encourage that continual round of wage demands upon the railways which regularly involve strike votes, public anxiety, mediation, arbitration and compromise. It has been an endless chain process, one section of the country being exploited by means of another; and railway employees previously satisfied have been stirred into restlessness by other classes of labor receiving unjustified wage increases. . . . The award recognizes this condition and there is not the slightest assurance that such practices will not continue."

railroads the right to be heard in arbitration on the claims made by them during their negotiations with the men?"

On July 29, 1914, President Wilson asked the representatives of both sides to go to Washington, and on August 2 (the World War having just started), he urged on the Conference Committee the acceptance of arbitration on the basis proposed by the men for patriotic reasons. He said, "I very earnestly urge your acceptance of that plan even though you may regard it as in some respects unfair to the interests you represent; and I am certain that in so doing you will perform an invaluable public service which will be everywhere applauded and deeply appreciated." The Conference Committee replied, under date of August 3, "In view, therefore, of the situation as you have presented it, and of your appeal to our patriotism and to our regard for the public welfare, we beg to express to you herewith our acceptance of the plan of arbitration proposed."

Arbitration was entered upon in August 3, 1914, with a board of six members. The Brotherhoods named F. A. Burgess, Assistant Grand Chief of the Brotherhood of Locomotive Engineers, and Timothy Shea, Assistant President of the Brotherhood of Locomotive Firemen and Enginemen. The railroads named H. E. Byram, Vice-President of the C. B. & Q. Ry. Company, and W. L. Park, Vice-President of the Illinois Central R. R. Company. These four, having failed to agree on the two neutral members, the U. S. Board of Mediation and Conciliation appointed Judge Jeter C. Pritchard, of Asheville, N. C., and Charles Nagel, of St. Louis, Mo. Judge Pritchard was elected Chairman.

Public hearings were held from November 30, 1914, to and including March 18, 1915. On March 29, 1915, briefs were submitted by both sides and arguments made from March 29 to and including April 2; 7828 pages of testimony were taken, 89 exhibits were presented by the employees and 50 by the railroads.

In its award, made on April 30, 1915, the board laid down no general principles nor did it discuss the merits of the men's demands. It set $4.30 as a minimum daily wage for

passenger and freight engineers, for passenger firemen $2.50, and for freight firemen $2.75, graduated upward according to weight on drivers; 100 miles or less, 6 hours and 40 minutes, or less, in passenger service, and 100 miles or less, 10 hours or less, in freight service, to constitute a minimum day's work. It also granted, in whole or part, some of the demands with reference to changes in rules governing working conditions.

Although Judge Pritchard, the Chairman, signed the award, he filed a statement in which he said, "I deem it proper to say that in my opinion the freight rates, as well as the yard rates for firemen and engineers, agreed upon by the board, are not as high as they should be."

The two railroad members of the board attached a statement in which they said:

Any scheme of standardization or approach to it which does not permit of equalization of dissimilar rates and rules, in our opinion, is unsound. The agreement under which the arbitration was held gave no latitude to the board to adjust or reconcile unequal conditions. It was one-sided. It permitted standardization only if upward.

In a statement which they filed, the labor members, declining to sign the award, said:

The very best that can be said of such an award is that it settles nothing, but simply postpones any further action on the questions involved for a period of 12 months. . . . The testimony presented by the employees showed conclusively that by the installation of larger engines and the development of larger freight train loads, the Western railroads had, during recent years, without any corresponding advance in rates of pay, added greatly to the physical work, the nervous exactions, and the already grave responsibilities of locomotive engineers and firemen. . . . No act (the award) by a Government tribunal could more keenly bring home to the wage earners of this great country the consideration they might expect if boards, under government supervision and control, were to review and adjust their wages and working conditions on that basis. The whole theory is so repugnant to us that we feel it our duty to advise not only all railroad employees, but every organization of labor, to seek, by every influence, to secure the revocation of a law

that has the smallest tincture of that principle embodied therein; for we believe that the application of such a theory brings us back to the practices and conditions of 200 years ago, and, if allowed to flourish and grow, will rapidly place the American wage earner in a condition similar to that of the Mexican peon.

237. Concerted Movements.—There is a further reason for starting a detailed consideration of wages with the year 1900. There was a virtual stabilization of wages from the period of the Civil War to the close of the last century, interrupted by some reductions during the panic period of 1873–1879, with additions to the real earnings growing out of improvements of the plant and practices, the resumption of specie payments and the decline of prices. But with changes in rates of wages begun in 1902, there was a change also in the manner of bargaining.

Until 1902, in the settlement of difficulties between the employees and the railroads, a unit no larger than a single railroad system was concerned. If a settlement could not be made for a railroad system, there might be a strike, and, while some of these strikes led to great disasters, they did not result in national calamities. The period of concerted movements, concluding with settlements with the carriers, covered the period 1902–1912, and largely grew out of a bitter rivalry between the Switchmen's Union of North America, strongly intrenched in all the large terminal yards, and the Brotherhood of Railroad Trainmen, growing rapidly in strength and determined to absorb that field in its jurisdiction. The occupation of the switchman was, in the days of the link-and-pin coupler, a highly hazardous one, and drew to it men of an adventurous type who strove desperately to defend the life of their organization. The railroads, because of the differing economic conditions surrounding them, were devoid of any unity of policy in labor matters and as a rule met each case in a spirit of opportunism.

The concerted movements of the men in forcing changes in wages and working conditions had been very successful, and the advances thus gained made very serious inroads upon the revenues of the carriers who sought relief through a

resort to arbitration, a method of settling industrial disputes then urged as a panacea with great vehemence in many quarters, and this continued from 1912 to 1916.

The advantage claimed for the concerted movement was that, affecting as it did an entire section of the country, the employees found that the railroad officers would settle directly, through mediation, or by arbitration, rather than permit so extensive a strike, that in short, the managers in such cases declined to take the responsibility of forcing a wage settlement by strike.

The first "concerted movement" was made by the conductors and trainmen, and they prosecuted six in all; three in the west, one in 1902, one in 1907 and one in 1910; one in the east in 1910, and two in the south, one in 1910 and one in 1912.

The enginemen prosecuted five in all; two in the west, one in 1906 and one in 1910; two in the south, one in 1907 and one in 1911; and one in the east in 1912.

The firemen prosecuted three in all; two in the west, one in 1907, and one in 1910; and one in the east in 1912–1913.

Demands were then prosecuted against the groups of roads in the three great traffic regions, finally concluding with the nation-wide effort of the four brotherhoods of 1916, who failed to reach an agreement with the National Conference Committee of Managers, consisting of eighteen members. Notwithstanding the efforts of the United States Board of Mediation and Conciliation the Brotherhoods refused to arbitrate the controversy, and this break-down of arbitration gave occasion for the passage of the Adamson Law, September 3–5, 1916.

Reviewing this long-drawn-out controversy, it will be seen that there were voluntary increases made by the Pennsylvania Railroad of 10 per cent on November 1, 1902, of 10 per cent on December 1, 1906, both extending to all classes of employees. In 1908 the 16-hour law was enacted by congress. Following the Baltimore & Ohio adjustment through Knapp and Neill on March 1, 1910, and the Clark-Morrissey-New York Central award of May 14, 1910, by January, 1912,

all the lines in the east had made a further advance of about seven per cent, and the cumulative effect was to increase the enginemen's wages, as compared with those of 1900, by 30.7 per cent. Further, the pay of the engineer advanced automatically with the introduction of larger engines, and, as this change was being rapidly effected, it was an important factor. Wages were further affected by the 16-hour law.

The arbitration award, effective on May 1, 1912, increased the pay of engineers four per cent, to bring the wages in the Eastern region into harmony with those in the Southern and Western regions, while the award of April 30, 1915, in the Western region again increased the disparity.

The railroads were insisting that there had been no substantial change in service conditions and that the wage rates were full and liberal; that there was no relation between the work that a locomotive could perform and the wage that an engineer should be paid; that the increased tonnage drawn by a locomotive no more entitled the engineer to increased pay than it did the conductor or any other member of the crew; that the engineer had been relieved of a large amount of work upon the locomotive often requiring two, three or more hours added to his road time, and that there had been no increase in risks or hazards because of track conditions or density of traffic, no increased responsibility because of increases in sizes of engines, no increased physical labor, while the standardized rate was chimerical and uneconomical and failed to take into consideration the differences in the character and the value of the service rendered.

The men were insisting that there should be the closest possible approach to uniformity of pay in service in a given territory, subject only in slight degree to some variations on account of differing conditions on different lines of railroads; that the engineer in making a wage schedule would not give consideration to density of traffic, the number of trains run, the kind of business, the size of engines and that kind of thing; that the engineer would work just as hard if there was only one engine on the road as if there were

a thousand; he gives his time, which is his whole stock in trade and is all he has to sell. They based their demands upon the grave responsibility, skill and efficiency required, the nervous exactions and the hazards of the profession, and the increased value of the service due to increased train loads. They were not unwilling to work a day of 10 hours, and believed it not unreasonable to ask that after a day of an exceptional number of hours, as compared with other occupations which receive time and one-half for overtime, they should be paid likewise for overtime service.

While the arbitrators complained that neither side presented principles upon which the questions at issue could be settled, they made no effort to discover or determine such principles themselves, nor had they the moral courage to apply the economic law of exchange; that "a thing is worth only what it will fetch." They found generally that standardization of pay and rules of service between traffic regions was impossible, that there had been no increase in the elements of risk and labor, that the extra productivity of the train came from the increased number and size of engines and that it was impossible to relate the facts as to profits to the question of wages in such a way as to found thereon specific increases in rates of pay; that punitive overtime is an unsound principle when applied to the running of trains; that the employee should be paid for all the service he renders and the company should not pay for any service it does not get; that the men have only their time and their labor to sell and should receive remuneration for the time they place at the disposal of the railroad as well as for the labor they expend in its service.

The effect of this experience upon the railroads was disastrous—they were being ground between the upper and nether millstones. In the Advance Rate Case in 1910, the Interstate Commerce Commission had said:

> Railroad labor, and certainly organized railroad labor, is probably as well paid, and some say better paid, than labor of other kinds upon the average. Railroad employees will hardly expect to receive wages which exceed those paid to other forms of labor for

the same grade of service, and this commission certainly could not permit a change of rates for the purpose of enabling railroads to pay their labor extravagant compensation as measured by the general average compensation paid labor in this country as a whole. It is likely, therefore, that the labor item of these railroads will not in the immediate future much increase unless there should be a general advance in prices.

Two years later we find the Arbitration Board in the Eastern engineers' case saying, "if they (the railroads) are not able to pay such compensation with existing rates, there is just cause for them to open again the question of an increase in rates with the I.C.C." And in 1913, we find the Arbitration Board in the Eastern Conductors and Trainmen case saying, "it must make its findings as to what is a proper rate of pay to be awarded to the conductors and trainmen as a result of this arbitration without any reference to the dilemma in which the railroads are evidently placed by the laws which make it impossible for them to increase passenger and freight rates without the authority of the I.C.C. or of the railroad commissions of the various states."

After the award in the engineers' 1912 arbitration and on March 30, 1913, Mr. Stone wrote to Mr. Brown, President of the New York Central Railroad Company, Chairman of the Presidents' Committee, saying:

> That the recent award was unsatisfactory to the engineers goes without saying and neither side expects them to accept it for any great length of time because the men on the heavy power are rightfully entitled to more money than the award gives them. While it is true that our present plan of handling these matters by concerted movement is a decided improvement over the old plan of the individual unit, yet the fact remains that we are making no progress. The last of the procession is still passing the reviewing stand when the front of the column appears in sight coming down the street. The result is we are getting nowhere and neither side is satisfied. My idea crudely stated would be this: that both sides sit down and discuss the matter in detail and see if it is not possible to agree upon fair rates and working conditions and then sign up for a period of three or four years.

The experience of 14 years of individual negotiation, of regional adjustment, of mediation and conciliation and of

arbitration was thoroughly unsatisfactory. The railroads felt that the cases were not settled on their merits but always compromised by giving the complainants some portion, greater or less, of their demands, that they encouraged a continual round of wage demands which regularly involved strike votes, public anxiety, mediation, arbitration and compromise, an endless chain process in which one section of the country was exploited by means of another, railroad employees previously satisfied being stirred into restlessness by other classes of labor receiving unjustified wage increases.

The employees were always disappointed at the small increases granted by the arbitrators when contrasted with their extravagant demands, contended that no principles were settled and that the questions involved were not disposed of but merely postponed for another year. Nor could they regard with indifference the large expense involved, nor the disclosure of the real situation, bared to the country by the publicity of the proceedings.

The experience clearly indicated that arbitration boards should be composed of men in no way connected with either side of the disputes under consideration. Where disputants are represented it merely carries the contentions of the two sides into the private meetings of the board and disturbs its judicial atmosphere. Arbitration was definitely breaking down.

238. The Adamson Law.—In March, 1916, the Big Four Brotherhoods, numbering approximately 400,000 men, gave the required 30 days' notice of the cancellation of their contracts and made demands, the most important of which were an eight-hour day and time and one-half for overtime for all employees in freight train and yard service. The railroads thereupon served notice that they wished certain counterclaims considered. As the negotiations were now for the first time to cover the entire country, a National Conference Committee of Managers, 18 in number, was organized to handle the matter for the railroads and conferences were carried on, June 1 to 15. These ended in disagreement, and

the men declined the companies' offer to arbitrate. A strike vote having been taken, conferences were resumed on August 8 and 9. Upon failure to agree and the Brotherhoods again refusing to arbitrate, the railroads invited the Federal Board of Mediation and Conciliation to exercise its office. That Board conferred with both parties to the controversy August 9 to August 13, inclusive, finally announcing that both parties refused to recede from their positions. Thereupon, President Wilson, on August 13, summoned the National Conference Committee of Managers and the Chiefs of the Brotherhoods to Washington. He made no effort to give force and effect to the Newlands Act, whose Board of Mediation and Conciliation were his appointees (though he later said in his message to Congress, "I yield to no man in firm adherence, alike of conviction and of purpose, to the principles of arbitration in industrial disputes"), but threw the weight and power of his office on the side of the men, and with great energy demanded that the conference committee accept the following settlement:

> That the railroads concede the eight-hour day.
> That the remaining matters in controversy be postponed until a later date.
> That a commission be appointed to study and report on the effect of the actual operation under the eight-hour day, to report without recommendation.

The chiefs of the brotherhoods announced their willingness to accept the plan; the conference committee declined to accept it on the ground that the principle of arbitration was sacrificed and that the increase of 25 per cent in the wage bill could not be borne by the carriers.

The President thereupon, on August 16, summoned the executives of the railroads, and in addition to the chiefs of the brotherhoods summoned some six hundred local chairmen. The President held conferences with the executives on August 18, 19 and 21, and several other conferences with a small committee.

The executives presented a counter proposal:

1. That the time of all employees in freight train and yard service be kept upon an eight-hour basis, recording the difference between the money actually earned on the ten-hour basis and the amount that would have been earned on an eight-hour basis—overtime to be computed pro rata.

2. That the Interstate Commerce Commission supervise the keeping of the records, and report, after a period of actual experience, the increased cost on the eight-hour basis.

3. That the President appoint a commission to investigate the whole subject.

Meantime the chiefs of the brotherhoods had left Washington and from their several headquarters on August 28 sent out an order for a strike to begin at 7 A.M. on Monday, September 4.

To prevent a strike, President Wilson proposed to Congress, in joint session on August 29, six recommendations as follows:

(*a*) The immediate enlargement and administrative reorganization of the Interstate Commerce Commission.

(*b*) The establishment of an eight-hour day covering all employees actually engaged in the work of operating trains in interstate transportation.

(*c*) Authority for the appointment by the president of a commission to observe the workings of the eight-hour day and to report their conclusions to Congress, without recommendation.

(*d*) Approval by Congress of consideration by the Interstate Commerce Commission of an increase in freight rates, if necessary.

(*e*) Passage of a law requiring a full public investigation of the merits of all labor disputes before a strike or lockout can be lawfully attempted.

(*f*) Authority for the President to assume control of such railroads and rolling stock as might be necessary for military purposes, with authority to draft into the military service of the United States such railway officials and employees as he deems necessary.

Congress considered favorably only the second and third

of these recommendations, and, on September 3–5, 1916, passed the Adamson Law which provided "that beginning January 1, 1917, eight hours shall . . . be deemed a day's work and the measure and standard of a day's work for the purpose of reckoning compensation . . . ." The act further provided "that the President shall appoint a commission of three to observe the operation and effects of the eight-hour standard work day as above defined during a period of from six to nine months and report its findings to the President and Congress." It further provided that the employees shall continue to receive the prevailing ten hours' pay for the eight hours' work, at least until 30 days after the report of the commission.

The President appointed as such commission, Major General George Goethals, Edgar E. Clark of the Interstate Commerce Commission and George Rublee of the Federal Trade Commission. They reported in due course to the following effect:

1. Complete elimination of overtime was not practical.
2. To increase the speed of trains by cutting tonnage is physically possible but available information strongly indicates that even with time and one-half for overtime it would, generally speaking, be more economical to continue present methods of operation.
3. Objections to a general changing of terminals practically insuperable.
4. Engines larger than those now employed might increase the strain on track and structures to a dangerous degree.
5. Engines with greater horse-power per ton of weight are desirable on many roads for increasing speed.
6. Shortening of local freight runs usually requires more engines and involves so much additional expense at terminals that a considerable increase in efficiency must be anticipated to justify changes.
7. Careful study should make it possible to eliminate some of the delays. Districts may be shortened or other improvements may be adopted, such as relaying of crews, improving signaling, increasing tracks or other facilities, using better fuel, or installing engines which will make better time without severe strain on track and structures.

The Adamson Act came up for adjudication in the United

States Supreme Court in the case of the Missouri, Oklahoma and Gulf Railway Company, wherein it was decided that:

The effect of the act of September 3-5, 1916, is not only to establish permanently an eight-hour standard for work and wages as between the carriers and employees affected, but also to fix a scale of minimum wages, to wit, the rate of wages then existing, for the eight-hour day and proportionately for overtime, to be in force only during the limited period defined by the act.

Viewed as an act establishing an eight-hour day as the standard of service by employees, the statute is clearly within the power of Congress under the commerce clause.

The power to establish an eight-hour day does not beget the power to fix wages.

In an emergency arising from a nation-wide dispute over wages between railroad companies and their train operatives, in which a general strike, commercial paralysis and grave loss and suffering overhang the country because the disputants are unable to agree, Congress has power to prescribe a standard of minimum wages, not confiscatory in its effects but obligatory on both parties, to be in force for a reasonable time, in order that the calamity may be averted and that opportunity may be afforded the contending parties to agree upon and substitute a standard of their own.

The business of common carriers by rail is in one aspect a public business, because of the interest of society in its continued operation and rightful conduct; and this public interest gives rise to a public right of regulation to the full extent necessary to secure and protect it.

Although emergency may not create power (*Ex parte* Milligan, 4 Wall. (U. S.) 2), it may afford reason for exerting a power already enjoyed.

The act above cited in substance and effect amounts to an exertion of the power of Congress, existing under the circumstances, to arbitrate compulsorily the dispute between the parties—a power susceptible of exercise by direct legislation as well as by enactment of other appropriate means for reaching the same result.

Viewed as an act fixing wages, the statute merely illustrates the character of regulation essential, and hence permissible, for the protection of the public right.

The act does not invade the private rights of carriers, since all their business and property must be deemed subject to the regulatory power to insure fit relief by appropriate means.

The act does not invade private rights of employees, since their rights to demand wages according to their desire and to leave the employment, individually or in concert, if the demand is refused,

are not such as they might be if the employment were in private business, but are necessarily subject to limitation by Congress, the employment accepted being in a business charged with a public interest which Congress may regulate under the commerce power.

The act is not wanting in equality of protection either because it exempts certain short-line and electric railroads, or because it deals with the wages of those employees only who are engaged in the movement of trains—they being the class concerned in the dispute which threatened interruption of commerce.

The history of the dispute, the inquiries and circumstances which culminated in the legislation, the nature of the provisions made and a comparison of them with the issues which existed between the disputants, refute the claim that the act was passed without consideration and in arbitrary disregard of the rights of the carriers and the public.

After the paramount duty to enforce the constitution, the very highest of judicial duties is to give effect to the legislative will, with judgment uninfluenced by those considerations which belong to the legislature alone.

The contention that the act is unworkable is without merit.

An understanding had been entered into by the railroads with the Attorney General to continue operations on a ten-hour basis but to give the men back pay from January 1, in case the law should be upheld. But the brotherhoods were not content to await this decision of the United States Supreme Court. A national strike was called for March 17, 1917, to compel the railroads to put in effect the eight-hour day without awaiting the court's determination of the constitutionality of the law. Members of the cabinet and a committee of the Council of National Defense appealed energetically to both interests. The brotherhoods agreed to postpone the strike date two days to March 19th, the first day on which the Supreme Court would meet to hand down decisions. The railway managers, because of the representations made to them of the acute international situation, authorized the committee of the Council of National Defense to grant to the employees whatever adjustment was necessary to prevent a strike. The council's committee thereupon, at 5:30 A.M. on March 19, made an award granting the eight-hour day to the men. Later that day the court upheld the law. Twenty days later the United

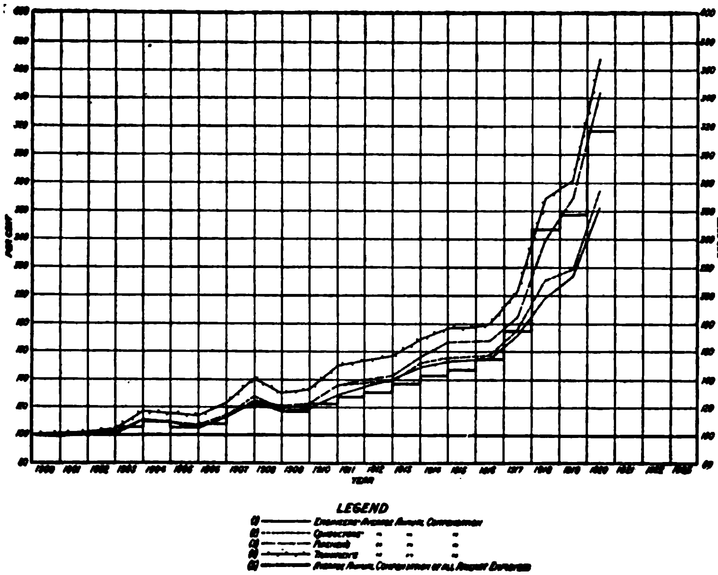

FIG. 65A.—AVERAGE ANNUAL COMPENSATION RAILWAY EMPLOYEES (1900–1920).

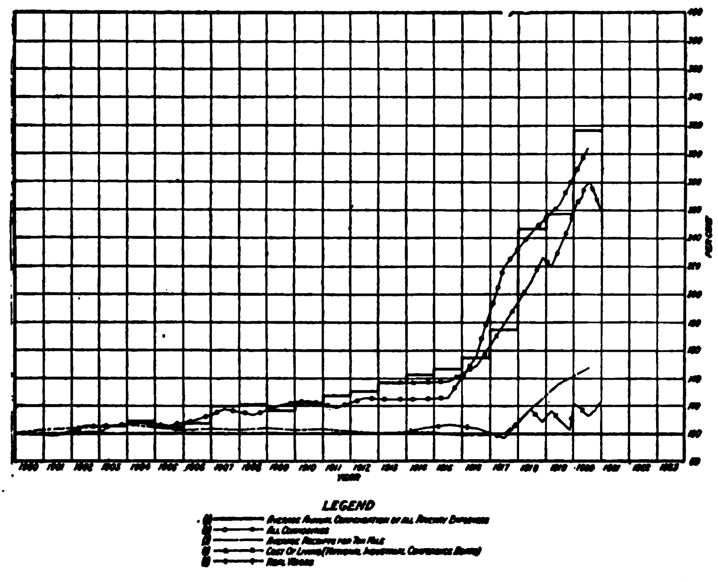

FIG. 65B.—RAILWAY RECEIPTS AND WAGES; COST OF LIVING AND COMMODITY PRICES.

States declared war on the Imperial German Empire. This whole episode was perhaps the most insolent humiliation ever put on a proud people. The Anglo-Saxon folk have a long memory. The day of retribution is not likely to be entirely avoided.

239. Conduct of Negotiations.—Growing out of these experiences certain conclusions were reached as to the procedure involved in handling them, and generally it was felt that the success of the negotiations depended largely upon the personnel of the conference committee, and particularly on its chairman, who should be able to maintain order and have sufficient initiative to carry forward each day the work along lines laid down with the advice and counsel of his committee. Members of the conference committee should be relieved from all the duties of their offices as operating officials. There should be no substitution on the committee during the progress of a conference, the appointment of a substitute having a most distracting effect. The conference committee should have all the authority possessed by those on the other side to deal with the questions presented. The labor entailed is arduous and special compensation should be made for it, and a committee should be generally recast for each succeeding negotiation. There should be a secretary-treasurer to look after the clerical work and to attend to the many disbursements which are inseparable from such work; also a statistical and clerical force with a competent chief, the success of the work depending largely on the care and thoroughness with which the material is prepared for use.

The negotiations should be conducted in a large room seating comfortably one hundred and with good light and ventilation. There should be two good-sized committee rooms for the use of the two parties, preferably connected with the main meeting room. The best results in negotiations are obtained by single sessions daily, usually from 10 A.M. to 1 P.M. Immediately following adjournment, the conference committee should lunch together where privacy is assured, followed by a discussion on the results

of the morning's negotiations. The committee should then determine its policy and the direction of the next day's work for the guidance of its chairman. This programme should be clearly defined before the committee adjourns in order that the preparation of such data as may be needed can be carried on by the clerical forces and made ready for use the next day.

Printed copies of the proceedings and reports of the committee in reference thereto should be preserved for future reference and use. After the conference committee is appointed the executives have, as a rule, no further office than to convene as an advisory board when called upon. As a rule such requests are not made until the negotiations are in their final stage.

240. Mediation.—The Erdman Act, providing for mediation and conciliation in industrial disputes, was enacted on June 1, 1898. The Newlands Act, which superseded it, was passed on July 15, 1913. These acts never commended themselves to either party for the obvious reason—that they never settled anything on principle.

In defining the functions of mediators Judge Knapp said:

> "I am rather inclined to say there is no right or wrong about wages or hours of service. . . . The law contemplates, as we think and as we have tried to administer it, that the duty of a mediator is not to form a judgment of how the controversy ought to be settled but to find out how it can be settled." Later, writing to J. O. Fagan, he said: "We have little or nothing to do with the merits of the case; our business and function is to keep the traffic moving."

241. Employment Relations.—If the men had chosen to develop their organizations along beneficial, fraternal lines, to use them to promote self-education and discipline, and as a means of strengthening their natural relations with their officers, I have not the slightest doubt that they would have fared far better than by the course they have pursued, a course which, in its effect upon the improvement of their relative position, can only be regarded as a miserable failure.

But while the demagogue may stir up a modicum of trouble by skillfully playing on the passions of the workers, the difficulties he creates reach an altitude of real seriousness only when the soil in which they are cultivated is made productive; when the unequal distribution of wealth, which is the natural result of the unequal distribution of intelligence, diligence, self-denial, opportunity, etc., etc., creates a misery that becomes intolerable; or the unequal distribution of power, which has its source in the same inequalities, creates an oppression that can no longer be borne. Whenever, then, friction arises, the efforts of the general manager should be directed, not merely to weeding out malcontents, but to a painstaking review of all the elements of the situation to set right at once all genuine or remediable grounds for agitation. While trouble-makers and causes for trouble often go together, they are nevertheless distinct and each should be searched out.

242. Wage Differential.—The relations of the various divisions of the service as to wages had tended toward stabilization over a long period of years, and with due regard to other industrial relations. These "differentials," so-called, were completely upset in 1918, shortly after the Government took over the roads. The Director General, Mr. McAdoo, appointed a committee of which the Secretary of the Interior was chairman, to take testimony and decide upon a new scale, and the finding of the committee, which seemed to be based upon some altruistic hypothesis having no relation to the long economic history of industry, destroyed the relations so long maintained. McAdoo's successor, Walker D. Hines, avoided the whole question when further advances were urged, and when it finally came up before the United States Railroad Labor Board in 1920, the leaders of the labor organizations had so aligned their relations with each other and with the American Federation of Labor, that the award maintained the situation created by the Lane Committee. It has been the cause of much heartburning and profound discontent and its ultimate status is problematical.

Approximately the increases in wages from 1915 to the peak in 1920 were as follows:

	Per Cent
Trainmen	106.7
Firemen	105.4
Engineers	72.4
Conductors	72.2

Assuming three trainmen to one fireman, and that these may be considered as analogous to unskilled labor in industry, their average increase would have been 105.7 per cent.

Assuming an equal number of engineers and conductors, and their occupations as analogous to skilled labor in industry, their average increase would have been 72.3 per cent.

That is, the wages of unskilled labor increased 46.2 per cent more than the wages of skilled labor. For this condition railroad officers were in no way responsible. It was the result of the Adamson Law and the acts of the director general and the Labor Board.

These different results are not to be explained upon any basis of free contractual relations, but apparently are the combined results of political and sentimental considerations or superiority of organization leadership.

Comparing these figures with corresponding figures in industry covering one and one-quarter million wage earners representative of the manufacturing activities of the country, we find that while the hourly earnings of skilled labor increased 149 per cent, hourly earnings of common labor increased 163 per cent, and that the increase in the earnings of unskilled labor was no more than 9.4 per cent greater than the increase in the earnings of skilled labor.

It is one of the singularities of the practical working of organized labor that in periods of sharp industrial activity, their wages increase more slowly than those of unorganized labor. In periods of sharp industrial depression they may retard, but they have never been able to prevent, the fall of the wages of their membership.

Looking now to the "real" wages, that is, the purchasing power of wages with relation to the cost of living, the "real" wages of the men in the train service were 20 per cent greater in 1920 than in 1914, while in industry they were something less than 14 per cent greater, and this advantage, while a very substantial one, is enjoyed only by the men who are actually at work and is at the expense not only of agriculture and industry generally but of all workmen whom the artificial status may have deprived of employment. In other words, this class of railway employees, while they did not fare so well during the war, are to-day something more than 42 per cent better off than industrial workers generally in their excess purchasing power.

Any discussion of rates of wages or rules governing working conditions with the chiefs of the train organizations behind closed doors is objectionable because they would come to the conference committed to the maintenance of these wage relations. The continued health of the employment relation, affecting not only employment on the railroads but employment generally in agriculture and in industry, can only be obtained by a proper readjustment of the wage relations through negotiations conducted in the open where all may be apprised of the facts involved and the governing conditions. Such information in regard to the relation between wages and conditions of employment is necessary on the part of those who may be interested in the negotiation, and this necessity must be impressed upon officers and all supervisory forces alike.

243. *Standard of Living.*—How our ancestors lived, it is difficult to understand. Underfeeding must have been a common experience. Progress in agriculture, industry and transportation has done much; compared with what was the case a century ago, we all live like kings. The contrast be-between Stephenson's "Rocket" and the latest Mallet is no greater than the contrast between the working conditions, the provision of the necessities of life, the prevention of disease, the security of person and property, in his time and our own.

244. *Relative Wages.*—It is, of course, fundamental that, due rewards should be given to workers, but they are offered only on the basis of service, efficiency and competency; and that each worker be held responsible for a standard production. In the railroad service, the men, besides the physical requirements, are held to a high state of discipline. In the main, they are subject to be called upon for duty at all hours of the day and upon all days of the year. They are under control, not only as to the disposition of their time, but as to some of their personal habits. They are engaged in a hazardous occupation. Having in mind the character of the forces so assembled, the restrictions imposed and the duties rendered, it is of the highest importance that relatively the rates of wages paid and the conditions of employment should be such as to attract and retain the pick of the industrial community.

245. *The United States Railroad Administration.*—There can be no question that the handling of the railroads for two years and two months by the federal administration, swayed as it was by political expediency, very much impaired their working and measurably destroyed the morale, and it is this last that must in the end cost us most. Since Napoleon, all great commanders have recognized that discipline and morale constitute at least three-quarters of all that goes to create success in battle (and the same is true in competitive business); material element, equipment, transport, numbers, etc., are quite subordinate. The changes are generally summed up as:

1. The changes in the wage scales, and their effect upon the differentials of pay for different employments.
2. The establishment of the eight-hour day with punitive overtime.
3. The abolition of piece-work in shops.
4. The inauguration of a rigid seniority rule in promotions and lay-offs, regardless of differences in individual ability.
5. The discharge of many of the traffic officers, and the loss of many officers who preferred work in other lines to the service as conducted.
6. The diminution of the disciplinary authority of officers.

The Board desires to point out that such overt acts by either party tending to and threatening an interruption of the transportation lines, the peaceful and uninterrupted operation of which are so absolutely necessary to the peace, prosperity and safety of the entire people, are in themselves, even when they do not culminate in a stoppage of traffic, a cause and source of great injury and damage.

The Board further points out for the consideration of employees interested that when such action does result in a strike, the organization so acting has forfeited its rights and the rights of its members in and to the provisions and benefits of all contracts theretofore existing, and the employees so striking have voluntarily removed themselves from the classes entitled to appeal to this Board for relief and protection.

The readjustments growing out of the war and the falling prices "affected all lines of industrial life all over the United States and produced conditions which have to be met and in whose burdens all have to share." The railroads recognized that in this readjustment reductions must be made in both wages and rates. Notice was therefore given by the railroads to the transportation employees in the Eastern Region on November 15, 1921, and in the other regions at approximately the same time, of their desire to negotiate new relations as to rules governing working conditions as contemplated in Interpretation No. 2 to Decision No. 119, dated June 16, 1921, and as to rates of wages.

247. Working Conditions.—No discussion of wages would be complete without considering the question of rules governing working conditions. As the United States Railroad Labor Board has stated, "the two matters are inextricably interwoven, many rules and working conditions governing the employees have a money value and it would be difficult, if not impossible, to give satisfactory consideration to the matter of wages until the rules and working conditions to which the wages shall apply are definitely fixed and known."

In the train and yard service there are some 134 matters coming under the heading of rules and working conditions that affect the operating practice. Much of the time of managements and committees is taken up in handling dis-

putes arising thereunder. The fact that in many cases they produce compensation out of all proportion to the value of any service performed naturally makes many railroad officials loath to apply them, while the same reason makes them very attractive to the men. These controversies cause much of the friction between managements and committees, and it is because of the effect on the morale that their elimination from the agreements with the brotherhoods has been sc generally desired by railroad officials. They limit the full use of equipment, appliances and personnel, cause much discontent and demoralization among the working forces by the manner in which seniority rights and other practices are applied, and cause also a very burdensome annual loss.

No reliable data have been collected that would enable an estimate to be made of the annual cost of these so-called "feather-bed" practices. The National Conference Committee of Managers, in connection with the eight-hour movement in 1916, collected some information on the subject but considered it of doubtful value owing to the different understandings with which the individual railroads viewed the requests for the information, and the lack of local records covering the payments. All agree that the one which involves the greatest expense directly measured in terms of money is punitive overtime.

Arbitraries and special allowances vary considerably under the individual schedules; some schedules contain practically every kind, while others are comparatively free from them. Their application has been irregular and in some cases they were introduced mainly for the purpose of preventing objectionable practices.

They have been brought about by two methods:

1. The method of legal enactment.
   (*a*) Laws covering sanitation and safety, factory inspection, safety appliances, etc.
   (*b*) Full crews, etc.
   (*c*) Restriction in hours, 16-hour law, 8-hour law, etc.
   (*d*) Age qualifications.
   (*e*) Restriction in the employment of youth and women.

2. The method of collective bargaining.
   - (*A*) Artificial scarcity of labor; designed to monopolize the employment.
     - (1) Limitation of apprentices.
     - (2) Long period of apprenticeship.
     - (3) Limitation of progression in a trade.
     - (4) Limitation in numbers.
     - (5) Hiring men.
     - (6) Promotions.
     - (7) Reëmployment.
     - (8) Elimination of handy-men.
     - (9) Opposition to new machinery and methods.
   - (*B*) Arbitrary restrictions of service, designed to make jobs.
     - (1) Full crews.
     - (2) Two firemen.
     - (3) Regulation of crews on mileage basis.
     - (4) Switching by road crews.
     - (5) Placing and removing supplies on engines and cabooses.
     - (6) Coupling and uncoupling hose.
     - (7) Chaining cars.
     - (8) Cleaning fires.
     - (9) Advertising vacant runs.
     - (10) Appeals.
     - (11) Leave of absence.
     - (12) Brakemen working as firemen when latter are unable to work on account of sickness.
     - (13) Baggage, handled by express messengers.
     - (14) Coaling engines.
     - (15) Doubleheaders.
     - (16) Double-crewed yard or helping engines.
     - (17) Discipline.
     - (18) Displacement rights.
     - (19) Engines running backward.
     - (20) Handling express and baggage.
     - (21) Inspection of engines.
     - (22) Laying off on account of sickness, disability or other causes.
     - (23) Making up trains (not road switching).
     - (24) Reducing lists, adjustment of runs.
     - (25) Regular men laying off.
     - (26) Switching outside assigned territory.
     - (27) Sunday work, regulations regarding.
     - (28) Handling light engines.
     - (29) Pilots, furnishing of.

(30) Seniority.
(31) Rest required.
(32) Throwing switches.
(33) Taking engines to shops.
(34) Work not required to be done.
(35) Work to be done at terminals.
(36) Watching engines.

(*C*) Arbitrary classifications designed arbitrarily to increase pay.
(1) Additional service prior to or after ending of day.
(2) Pay when assigned to other than regular duties.
(3) Short turn-around service in freight.
(4) Craft classification.
(5) Outside hostler's rates.
(6) Mixed train service.
(7) Stop rule.
(8) Branch line rates.
(9) Six-hour Mallet day.
(10) Asst. conductors and ticket collectors, rate of pay, passenger.
(11) Automatic release.
(12) Breaking in engines.
(13) Rear brakemen and flagmen, pay, passenger service.
(14) Classification of engines.
(15) Deadhead passenger equipment, pay for handling.
(16) Electric service.
(17) Mileage allowed, method of calculating, etc.
(18) Mileage, terminal.
(19) Maximum mileage.
(20) Pilots, pay for.
(21) Shop engines.
(22) Local and way freights, Sundays, etc.
(23) Local and way freights, when tied up under orders.
(24) Local freights, defined.
(25) Snow plows and steam shovels.
(26) Special trains.
(27) Transfer and drag service.

(*D*) Duplicate payments for the one service.
(1) Punitive overtime.
(2) Initial terminal overtime.
(3) Final terminal overtime.
(4) Arbitrary application of minimum day.

(5) Short turn-around passenger service overtime.
(6) Yard crews working beyond switching limits.
(7) Road firemen shoveling down coal and cleaning fires.
(8) Combination service, pay for.
(9) Change of limits of runs.
(10) Doubling hills, pay.
(11) Detouring trains, pay for.
(12) Helpers or pushers on locals.
(13) Home terminal, changes in.
(14) Overtime basis, passenger service.
(15) " " through freight service.
(16) " " work trains.
(17) " " wreck train service.
(18) " " pusher and helper service.
(19) " " mine run and roustabout.
(20) " " circus trains.
(21) " " milk trains.
(22) " " local freight.
(23) " " yard service.
(24) " " belt line or transfer service.
(25) " " electric service.
(26) " " mixed service—freight and passenger.
(27) Short trips, pay.
(28) Switch engines used as pushers.
(29) Transferring engines and cabooses.

(*E*) Pay for service not performed.
(1) Guarantees in passenger, local freight, work, wreck, yard, and construction service, etc.
(2) Held away from home terminal.
(3) Lunch time, road and yard.
(4) Called and not used.
(5) Deadheading.
(6) Learning road.
(7) Taking examinations.
(8) Disabled or disqualified employees, positions for.
(9) Disabled engines, crews staying with.
(10) Rest, pay for when losing turn.
(11) Service, pay when held for.
(12) Relieved only at terminals.
(13) Releasing crews at designated points.
(14) Trip not completed.
(15) Transportation.
(16) Transportation, household goods.

The following are types of restrictions affecting the administration of the business, but not subject to the above classification.

(1) Agreements, change in.
(2) Arbitraries and special allowances (Arts. X and XX of Sup. Nos. 24 and 25).
(3) Bulletin boards.
(4) Bulletin, weight on drivers of locomotives, posting of.
(5) Calling of men.
(6) Crews, make up of, number of men.
(7) Day, definition of (calendar).
(8) Exceptions to rule for 100-mile or 8-hour day.
(9) Gasoline motor service.
(10) Irregular service.
(11) Ice and water.
(12) Official positions.
(13) Regular assigned men, required to remain in calling distance.
(14) Reports.
(15) Registers.
(16) Service letters.
(17) Time reports.
(18) Time, when not allowed as claimed.
(19) Uniforms.

248. Piece-work.—The mind of the worker is stimulated to activity by the desire to earn more; ambition is aided by opportunity and grows as it is accepted. The piece-work system reacts favorably upon the mind and character of the worker. Though always spoken of as a method of payment for work done, it is far more than that, being both a method of management and of shop organization. Piece-work causes an entire change in the handling of men and under such a wage scale the men themselves are more contented. Under the hourly wage system it is necessary to drive them along in order to get them to do a fair amount of work. The method of work is laid down by the foreman and he applies the pressure necessary to obtain the output. The interest of the worker is lost and antagonism is set up. Under the piece-work system the man (or gang) does his own driv-

ing, lays out very largely his own work and varies the methods to obtain greater results and maintains coördination and order. It is important in setting up piece-work rates to set them correctly the first time and no amount of preliminary study is wasted, as changes in rates are the cause of much dissatisfaction. A systematic study of labor activities under varying conditions should be made with a view to determining production standards that may be generally brought into use. The usual practice is to use as a standard of production the output of the average man. Under a properly determined and applied piece-work basis of compensation, the production of labor is substantially increased. When the director general, yielding to the pressure of the American Federation of Labor, abolished piece-work, the records of many shops showed a falling off in output per man from one-third to one-half.

249. Seniority.—The seniority question has added numerous rules to the average schedule, all designed to surround the seniority of employees so as to protect them in every way. This has become one of the vital elements in the relationship between management and employee. The subject has been dealt with in such a manner as to insure seniority preference to employees irrespective of ability or fitness. Seniority has been a real setback to the up-to-the-minute man and there is hardly any question but that it has been a great drag on the railroads. Railroads should not be bound by rigid rules that do not take into consideration qualifications other than the seniority status. Merit and ability as well as capacity for increased responsibility should govern and the fair and impartial treatment of employees, giving due consideration to these factors, should enable railroads to operate with greater efficiency. The "bumping" of junior employees often works great hardship upon them as well as loss to the company.

250. The Basic Day.—The agitation for the eight-hour day in the industrial field was based largely upon the divisibility of the 24 hours into three equal periods, and the effectiveness of the slogan, "eight hours for work, eight

hours for play and eight hours for sleep." The claim was furthermore confidently made that production per man under the eight-hour schedule would be greater than under a ten-hour schedule. No investigation was made to develop the facts in this latter regard, nor to ascertain whether the world could support itself on such a basis. The world was steadily improving its condition under a work day of 10 hours. Manifestly, life could not be maintained were no work done. There must necessarily be a point beyond which, were hours of work to be further reduced, we should inevitably go backward. Nor was any consideration given to the effect created by so glaring a difference between the conditions of industrial and agricultural labor. In many cases the real incentive was not to shorten the day to eight hours, but to maintain a longer day and enjoy the benefit of punitive overtime after eight hours.

My own feeling is that the spread between the eight-hour and ten-hour day should be utilized for the benefit both of the community and the workman; that when times are hard and men are being thrown out of employment—generally by reduction in forces—it is desirable, as a general rule, before discharging men from service, to reduce the working hours to eight or their equivalent. Even in severe panics seldom does production for a year fall off so much that this margin of 20 per cent would not be sufficient to protect the situation. But this method of distribution of work in hard times to decrease unemployment may easily be carried so far as to bring disastrous results, involving all on the payroll in the calamity of inadequate earnings.

It was this mistake on the part of the railroad companies, however benevolent the intention, that was the underlying cause of the great strike of 1877. When times are good and it is difficult to secure the additional labor required, the hours of labor should be increased from eight to ten and overtime paid only after ten hours. Unless this is done, men are invited from other industries into those using the short work day, throwing the whole labor situation out of equilibrium, the drain of the cities upon the country popu-

lation is increased, while immigration is invited from abroad, making abnormal and permanent additions to the number of workmen and entailing unfortunate consequences in many directions. The enactment of the Adamson Law arbitrarily establishing a standard of an eight-hour day in train service has only resulted in producing a measure upon which compensation is based. This is further aggravated by the practice of paying punitive overtime. The character of the train service, where the movement is in a measure under the control of the employee, makes difficult intense supervision, and admits of waste in time and performance which cannot always be checked. The spread of a day's work within reasonable limits should be based on the class of service and work performed with compensation upon a single standard of pay.

251. Overtime.—Punitive overtime should not be paid in train service. Over a long period of years the terminals were located with reference to a run of 100 miles in 10 hours. The compensation was fixed fully to compensate the men working under conditions that cannot now be changed, so that with punitive overtime they are further compensated for the same work.

The public demand for continuous transportation service requires railroads to perform service consistent with its needs. In performing this service there appears to be no justification for penalizing a business the nature of which is continuous 365 days of the year. It has always been the policy of railroads to perform only such service on Sundays as conditions may require, and, in identifying themselves with the railroad business, employees recognize this requirement. With the proper spread of hours pro rata rates should prevail in all classes of service rather than punitive rates, and in the event of unusual conditions any reward for such service should be based on the merits of the case.

252. Arbitrary Restrictions of Service Designed to Make Jobs.—Enactment of legislation together with a large number of rules regulating service and placing restrictions on the work to be performed has resulted in an arbitrary increase in forces, and is unwarranted and uneconomical. The

right of management to adjust its forces in the interests of safe and economical operation should not be abridged by legislative and restrictive rules that have become part of schedules under the pretense of safety or for other reasons urged by the employees' organizations. There is no defense for the prohibition of double-heading on grades of less than one per cent. It is a device for restricting output, opposed to economical production.

253. Classification of Work.—The ever-increasing technical classification of work can only be designed to affect compensation. Each new classification generally carries an individual rate. Performance of work under several classifications involves payment of the highest rate irrespective of the character of the work performed, or the fitness of the employee. Under a proper basis of compensation it should be possible to reduce the classes to a limited number which might properly describe duties; such limited classification to permit the free and unrestricted utilization of the services of the employee.

254. Duplicate Payment for Service.—Rules of this character, such as final terminal delay, combination service, switching beyond yard limits, etc., not only have the effect of increasing compensation, causing an unwarranted payment for a service, but are restrictive in operation making it necessary in most instances to so arrange service as to guard against duplicate payments. Much time and attention is given in arranging service to avoid as many of these penalties as is possible. Under a fair basis of compensation, management should have the widest latitude in adjusting the necessary service without first giving consideration as to the extent the service will be affected by numerous rules.

255. Pay for Service not Performed.—The employer is entitled to the maintenance of a full standard of production during the entire period covered by the term of service. The arbitrary fixing of guarantees, lunch time, payment for taking examinations, learning road, etc., are largely the result of old rules applied to new conditions and new basic rates. There does not appear to be any justification for the pay-

ment for service not performed and while it is true that in train service specific time cannot be set up for men to enter or leave the service, the compensation received would appear to be ample in view of the conditions of employment. There may be some requirements of the service for which the employee would be justified in seeking compensation and in the event that the management could not so adjust its operation as to obviate the conditions under which the employee makes his claim, consideration should be given to such claims. In discussing this and other principles, management should be willing to accept its full responsibility in any necessary adjustment.

256. Restrictive Rules Covering Miscellaneous Matter.—Numerous rules appear in schedules covering matters such as the establishment of bulletin boards, calling men, etc., outlining the manner in which routine matters shall be handled. If designed to cover certain routine matters where they have already served their purpose, there would appear to be no justification for continuing such rules from year to year. These are among the useless matter in schedules and, in any thorough discussion, should be eliminated.

257. Future Relations.—The above suggested principles might properly be set up as the basis of a study on the part of the management and representatives of the men with the view to determining the possibility of discussing these issues in the light of present day conditions. Many of the rules now in effect arose from complaints on the part of the employees of failure to recognize obvious abuses and bad practices. Management, having knowledge of these conditions to a considerable extent, has taken steps in various ways to overcome the objectionable features. Well-defined measures have also been taken to establish better understanding and closer working arrangements. It may, therefore, be said that at the present time many of the rules contained in the schedules have accomplished their purpose, and by recognizing that management has no desire to be other than just and reasonable in dealing with the employees, a new understanding should be possible, agreeing upon basic

principles and writing around such principles new rules which would eliminate some rules and restrict others, giving management a proper return in exchange for a fair compensation.

Approaching this subject in a fair and impartial manner it would seem that management and the representatives of the employees might go far in writing a schedule that would insure to the employee the maximum compensation in return for the maximum unrestricted service, injecting into such schedule only matter pertinent and absolutely necessary. Any conference looking toward negotiations of this character should be entered into by management with a clear understanding of its responsibility in dealing fairly and justly with the employees, and this spirit is not only necessary on the part of those who may be interested in the negotiations, but should be impressed upon officers and all supervisory forces alike.

As to the determination of wages, I know of no theory that seems at all workable, except that of the value of the service under the relations between supply and demand, which, of course, as matters now stand, do not work with entire freedom. It is of interest to find as late as this year, Dr. A. L. Bowley, one of the most distinguished of the modern economists, saying that, "No definite criterion has yet replaced the pre-war method of determination of wages by the market value of labor."

If the criterion of wages is to be the value of the service rendered, then we must get away from the observance of standardized pay and consideration must be given to the great difference in the value of the service on a line of heavy traffic and on a branch line of thin traffic and under similar instances of governing conditions.

Unfortunately, economists have been of but little help in the determination of these problems. Among the complaints that might be lodged against all writers on economics is the loose way in which they use language. If the economist would use "labor" where the use of muscular strength is meant, and "laborer" where the individual exerting strength

is meant, it would be of great assistance to the lay reader. They dwell interminably upon the problems of distribution, but neglect the problem of production which precedes distribution.

They fail to distinguish the spendable income remaining after income has been subjected to deductions on account of the expense of government, and the savings necessary for the progress of the increasing population. They harp upon the waste of a limited number of people who live luxuriously and fail to point out that the waste of the laborers in total is far greater than the waste of the rich. They criticize severely the idleness on the part of the wealthy, though Dr. Bowley, who investigated the matter carefully in England, concluded "that the number of unoccupied persons with incomes over eight hundred dollars is insignificant," but leave unnoticed the greater idleness on the part of the laborers through limitation of output, limitation of hours, and other devices for avoiding work. They fail to distinguish sharply the fields of management, capital and labor. It is conceivable that capital in its present hands might be entirely supplanted by capital furnished by the workers in an industry. But management is a function of those possessing a high level of mental efficiency.

They assume that there are no "differences of inborn gifts" which would lead to a limitation of the flow of labor into the upper grades, or lead to a separation of grades, but assume that all men are in their own spontaneous way artists and creators. These views are definitely challenged by the results of tests of mental efficiency and need serious review. All history teaches that progress of the race is consequent upon three institutions—the institution of the family; the institution of private property, and the institution of a settled government based upon order, justice and sound morals. Before we abandon these to venture off into the unknown, much consideration should be given to the fundamental facts involved, many of which not only have not yet been determined, but have not even been seriously considered or discussed.

258. Railroad Accidents.—The pioneer railroad, the Liverpool and Manchester, had been at length completed and its board of directors had resolved upon a gala event to usher in the new instrument of transport. George Stephenson, himself, drove the "Northumbrian," his son, Robert, the "Phoenix," his brother, Robert, the "North Star," while the famous "Rocket" was driven by Joseph Locke, the "Dart" by Thomas Gooch, the "Comet" by William Allard, the "Arrow" by Frederick Swarrick and the "Meteor" by Anthony Harding. There were 33 coaches, those of each train being distinguished by different colored silk flags. Later there came another demonstration when in 1881, on the one hundredth anniversay of the birth of George Stephenson, many of the finest locomotives then in Great Britain were sent by the principal companies to file in procession at North Wylam before the thatched cottage in which he was born. But the earlier event was distinguished from the latter by a sinister incident. Charles Francis Adams writes that "with a true dramatic propriety, the ghastly record, which has since grown so long, began with the opening of the first railroad—literally on the very morning which finally ushered the great system into existence as a successfully accomplished fact, the eventful 15th of September, 1830—the day upon which the Liverpool and Manchester Railway was formally opened. All the trains had started promptly from Liverpool, and had proceeded through a continuous ovation until at 11 o'clock they had reached Parkside, 17 miles upon their journey, where it had been arranged that the locomotives were to replenish their supplies of water. The road was laid with double tracks and the eight trains were running four trains on each track, in the same direction. As soon as the trains had stopped, disregarding every caution against their doing so, the excited and joyous passengers left their carriages. William Huskisson, then a member of parliament for Liverpool, and eminent among the more prominent men of the day as a financier and economist, caught the eye of the Duke of Wellington, and going up to the door of the state carriage, he and

his former chief shook hands and then entered into conversation. As they were talking, the Duke seated in his car and Huskisson standing between the tracks, the Rocket locomotive came along upon the other track, so slowly and silently it was hardly noticed. In addition to being lame, Huskisson seemed also under these circumstances to be quite agitated; he nervously tried to get around the open carriage door, which was struck by the approaching locomotive, flinging it back and throwing him down. He fell on his face in the open space between the track, but with his left leg over the inner of the two rails upon which the "Rocket" was moving, so that one of its wheels ran obliquely up the limb to the thigh, crushing it shockingly. He was placed in one of the state carriages, and in 25 minutes was carried to Eccles, a distance of 17 miles, where medical aid was obtained, but upon the evening of the same day, before his companions of the morning had completed their journey, he was dead."

In 1874 the English Royal Commission reported that it appeared from the companies' records of men dismissed for drunkenness, and fines and cautions imposed for this cause, that the annual number of such cases is considerable.

Writing in 1909 Wilson felt that since that report was issued the nation had grown more sober and in no path of life more so than in the railroad service. The United Kingdom Railway Temperance Union had been organized, was most active and had received the strong support and financial assistance of railway directors and officers. He thought that at that time cases of railway accidents in which men were under the influence of drink were most rare. In this country for many years this regrettable cause involved many calamities. At least a third of the accidents were connected with hand brakes and the link and pin coupler. The Pennsylvania Railroad used to place on either side of the coupler stem a "dead wood" which made the manner of handling the link as practiced on some other lines highly hazardous. I remember being told by a yard brakeman that, in his wandering through the southwest as a "stake-man," his

statement that he came from the Pennsylvania Railroad was always challenged, attention being called to his having all his fingers. His reply never failed to carry conviction. "I never," he averred, "go between the cars when I have more than three drinks of whiskey in me." Mr. S. L. Coffin, who had served as a railroad commissioner in Iowa, later devoted himself to promoting the cause of total abstinence. "This wonderful movement among the men themselves in the interest of total abstinence from all that intoxicates, whether on duty or off, as witnessed by the remarkable fact that in one short year from its inception nearly 100,000 practical railroad men have put on the white B.R.T.A. button of total abstinence from all that befuddles the brain, is one of the grandest movements on the road of safety appliances ever undertaken by railroad men."

Happily with the passing of time there has come a general recognition of the necessity for clear-headedness in this service and cases of drunkenness are now seldom encountered. But there is much reason to complain of recklessness, carelessness, indifference, lack of understanding, discontent and sometimes virulent fomenting of trouble. The weeding of the ranks to free them from these types should be incessant. It is unfortunately not practiced with sufficient energy. A railroad should never be made a paternal or benevolent institution to shelter persons who do not perform the duties required of them. Especially during times of slack business, when there are not so many freight trains and the men are less rushed, attention should be directed to a close inspection of appliances, of regulations, of training and of discipline. Discipline offers one of the greatest fields for improvement. All investigators agree that there are few train accidents due to causes beyond the control of man. The business is a hazardous one and many of the well-meaning efforts to reduce its hazards are not only futile but react to slow down the flow of traffic. Too often when an accident occurs the only lesson to be learned from it is the old one—the necessity at all times of complying exactly with all rules and regulations. Fortunately we

may rely with confidence upon the intelligence, the quickness of perception and the resourcefulness in taking care of himself that is the peculiar characteristic of the American railroader. But the matter of accidents is of such consequence that there should be a clear recognition of the responsibilities of all involved and a united discharge of duty in providing safeguards. Too often there is a senseless or unjust abuse of companies or officers, when public opinion should hold responsible reckless, indifferent or careless employees, who flagrantly disregard carefully devised regulations or the common dictates of prudence. At the very beginning, Judge Potts, of New Jersey, in the trial of an engineman of the train at the time of an accident on the old Camden and Amboy Railroad said, "It is time that men assuming the high responsibility connected with this popular and universal mode of travel, should come to know that dismissal from the service is not the only penalty for gross negligence involving destruction of human life. . . . There is no question about the duty of the courts and juries to convict and punish these offenses where guilt is proved. I say guilt, for gross negligence, which produces death, is guilt." But nothing will lessen the responsibility of the officer in his exercise of discipline in both its aspects; to weed out the unemployable and the "bad order" men; and to press the education and training of the others through examination upon the rules and instruction in the use of appliances and the methods of operation. In his relations with these men he must face their wiles, which are remarkable, with calmness; and he must win their respect, which is difficult to win, by capacity. He should keep in mind, as well, the effect in reducing accidents of the regularity and punctuality of service. He should issue his orders so that they may admit of only one meaning, leaving no latitude of interpretation by subordinates.

There has been a vast improvement in the design of appliances both in character and in increasing the safety of working. The automatic coupler, the Westinghouse Brake, the interlocking and block signaling are perhaps the most

conspicuous, but there is literally a host of others, the combined influence of which can be hardly less. So that it is not without reason that, while accidents prior to 1877 might be felt to be due more largely to failures of the machine, certainly now far more often the man is at fault. In the end we are brought to improvement in appliances, care in selection, education, training and discipline of the men and relation of officers and employees. If the employee is the right sort, he is a willing instrument, but the officer must know how to manage him. He must find the way to enlist the best efforts of the men by arousing their devotion, not their fear, by making them regard his opinion as having value, and by making himself beloved.

One hears a good many adverse comments in comparing American with foreign experience. The great difficulty in comparing results deduced from what may seem to be equally complete statistics of different countries lies in differences of nomenclature and in the variety of arbitrary rules which affect the computations. Nor do such computations disclose "third factors" which may be of dominant effect.

The most common challenge is the alleged difference in the disposition of the crossings of railroads and highways. The existence abroad of level crossings is much more common than is generally understood. In motoring in 1913 up the Rhine from Coblenz to Mainz and across country to Heidelberg, about 100 miles, I counted 22 highway crossings, one underneath, two overhead and 19 at grade. Level crossings are as frequent in Germany as here for the same area. I once saw the statement that there were more than 22,000 of them and I should think it true. Conditions are not very different in France or the north of England, though in the south of England level crossings are more rare. The great difference in foreign and American conditions is the attitude of the public authorities. In France and Germany when a train leaves station "A" to go to "B" a signal is given at each intermediate crossing flagman's box. The gates are closed not to be opened until the train has passed. The highway is closed and any one attempting to cross is

punished. In England the crossings are usually protected with high, strong gates, completely closing the highway when trains are passing and swung in so as completely to close the right-of-way against trespassers when the highway is in use. Whatever may be the state of our laws for the protection of the public and the railroads, they have no existence in the minds of public officers. The railroads are the highways of criminals, vagrants, unemployed, of mischievous boys who "hop" the trains, of young men going back and forth from town to town, and of a stream of people who travel them on foot. Adequate legislation and adequate police protection would greatly reduce the casualties to travelers on the highways and to trespassers.

Accidents divide into those for which the railroad companies may fairly be held responsible, defects in track, in equipment, etc., etc., and those for which they cannot be held responsible because beyond their control, as by obstructions, by malice, by disregard of property rights, by negligence or by disobedience of orders. They involve employees, passengers, travelers on the highways and trespassers. They are classified as injuries and death.

Bad as the records may be found, their truth can only be appreciated when they are considered in relation. We must have in mind the multitudinous hazards of existence, the ravages of disease, the devastations of pestilence, the inevitability of death. Not without reason, then, does Adams assert that, viewing at once the speed, the certainty and the safety with which the intricate movement of modern life is carried on, there is no more creditable monument to human care, human skill, and human foresight than the statistics of railroad accidents.

From 1870 to 1880, Adams estimated that the average travel on the railroads of Massachusetts was 80,000,000 miles before being killed and 11,000,000 miles before being injured or killed. While during the long years that have followed the accident roll has been a large one, its aspect has sustained material changes.

The definition of terms and of the data covered by the

statistics of railroad accidents were set forth in the requirements laid down by the Interstate Commerce Commission, based upon the recommendations of a committee of the American Railway Association headed by Julius Kruttschnitt. The changes then made, while placing our records more nearly on the same bases with those of European countries, differ so widely from those previously kept that comparisons of earlier and later periods are difficult to make. Since 1911, the following tables, Figures 66 and 67, show the experience of the roads.

259. Levels of Human Intelligence.—Human conduct is determined by a great variety of factors—emotion, temperament, will, knowledge, attention, memory, perception, reasoning, etc., etc. Some or all of these are combined into that function which is called intelligence. Investigations made by Barnes, at Vineland, N. J., and by Binet, in Paris, determined: that the capacity for intellectual development is largely independent of what we call learning or knowledge; that not all develop to the highest level of intelligence, or even near to it, many stopping at one of the lower levels of childhood; that every human being comes into the world with a potentiality for mental development that will carry him just so far, nothing affecting the mental level to which he will finally attain, intelligence being believed to be dependent upon the structure of the brain cells and upon their functioning; and finally that it is possible to observe and measure this development independently of acquired knowledge, intelligence being the potentiality of the machine and knowledge the raw material upon which it works. Low grade intelligence cannot use much knowledge, while the upper limit to which intelligence can be utilized in correlation with knowledge is as yet not accurately determined. The value of intelligence lies in the fact that it enables instinct to adapt itself to the special circumstances of the moment and thus to bring about its end more surely.

We might long have regarded those additions to the sum of our knowledge as holding a mild interest for us had it not been for our entrance into the World War. One million and

seven hundred thousand men were drafted into the army, representing a fair sample of the population of the United States. The facts determined in regard to that group of

FIG. 66.—ACCIDENTS ON STEAM ROADS IN THE UNITED

TRESPASSERS	1911	1912	1913	1914
Employees				
Killed	......	......	......	......
Injured	......	......	......	......
Other persons				
Killed	......	......	......	......
Injured	......	......	......	......
Total trespassers				
Killed	5,284	5,434	5,558	5,471
Injured	5,614	5,687	6,310	6,354
NON-TRESPASSERS				
Employees on duty				
Killed	2,871	2,920	2,939	2,523
Injured	45,848	49,120	56,619	50,841
Employees not on duty				
Killed	292	315	362	327
Injured	954	959	1,178	1,097
Passengers				
Killed	356	318	403	265
Injured	13,433	16,386	16,539	15,121
Persons carried under contract				
Killed	*	*	*	*
Injured	*	*	*	*
Other non-trespassers				
Killed	1,154	1,198	1,288	1,307
Injured	5,073	5,023	6,042	5,975
Total non-trespassers				
Killed	4,673	4,751	4,992	4,422
Injured	65,308	71,488	80,428	73,034
Total persons				
Killed	9,957	10,185	10,550	9,893
Injured	70,922	77,175	86,688	79,388
Total employees	1,599,854	1,642,119	1,759,020	1,640,029
No. employees per person killed	161	161	166	165
No. employees per person injured	23	21	20	21
Total traffic units handled	†346,957,500,681	†356,930,415,845	†399,347,786,567	†388,625,705,960
No. traffic units per person killed	34,845,586	35,044,714	37,852,871	39,282,897
No. traffic units per person injured	4,892,100	4,624,948	4,606,725	4,895,270

* Included in "Passengers." † Year ending June 30th.

NOTE.—Classification changed in 1917. Prior to that

men will probably be found applicable to the country as a whole. By the methods employed, a depot brigade of raw recruits could be tested by the psychologist in an hour or two, and the commanding officers be given the results in-

dicating each man's probable value in the service which would take them six months to learn in the ordinary routine of drill.

States for the Years 1911 to 1920, Inclusive

1915	1916	1917	1918	1919	1920
......	......	149	74	133	89
......	......	207	98	193	189
.....	......	4,094	3,181	2,420	2,077
......	......	3,622	2,707	2,465	2,179
5,084	4,928	4,243	3,255	2,553	2,166
6,448	4,793	3,829	2,805	2,658	2,368
1,594	2,210	2,616	2,759	1,693	2,107
38,060	48,310	52,236	46,961	36,280	46,920
215	303	165	169	66	91
840	811	544	595	321	314
222	291	301	471	378	229
12,110	8,008	7,582	7,316	7,456	7,591
*	*	42	48	28	35
*	*	792	766	691	865
1,163	1,744	2,200	1,995	1,882	1,867
5,390	5,060	5,987	5,701	5,195	5,728
3,194	4,548	5,324	5,442	3,942	4,329
56,400	62,189	67,141	61,339	49,943	61,418
8,278	9,476	9,567	8,697	6,495	6,495
62,848	66,982	70,970	64,144	52,601	63,786
1,366,316	1,599,158	1,732,876	1,837,663	1,913,422	2,012,706
165	169	181	211	295	310
22	22	24	29	36	32
†369,282,791,130	†440,808,048,125	512,895,976,140	568,031,451,262	534,753,962,949	587,824,130,830
44,610,146	46,518,367	53,610,952	65,313,493	82,333,174	90,504,100
5,875,808	6,580,992	7,226,941	8,855,566	10,166,231	9,215,567

year, detail as to "Trespassers" was not reported.

The rating earned furnished a fairly reliable index of the man's ability to learn, to think quickly and accurately, to analyze a situation, to maintain a state of mental alertness, and to comprehend and follow instructions. The score

FIG. 67.—TRAIN ACCIDENTS AND TRAIN SERVICE ACCIDENTS TO EMPLOYEES, BY CLASSES, ON STEAM ROADS IN THE UNITED STATES, 1911 TO 1920, INCLUSIVE

Employees on Duty	*1911	*1912	*1913	*1914	*1915	1916	1917	1918	1919	1920
Road Trainmen	905	917	869	738	409	794	1,492	1,606	984	1,265
Killed										
Injured	21,514	22,390	25,142	21,281	15,444	27,007	47,887	42,944	32,844	42,840
Road trainmen in yards										
Killed	313	265	304	260	176	†	†	†	†	†
Injured	7,792	8,202	9,041	8,934	7,162	†	†	†	†	†
Yard trainmen										
Killed	490	481	527	479	299	445	†	†	†	†
Injured	11,702	13,383	16,810	15,703	11,695	16,922	†	†	†	†
Switch tenders, crossing tenders and watchmen										
Killed	106	125	125	116	62	88	†	†	†	†
Injured	439	439	456	432	397	384	†	†	†	†
Trackmen and bridgemen										
Killed	570	660	651	540	359	474	†	†	†	†
Injured	1,394	1,760	1,989	1,767	1,286	1,044	†	†	†	†
Other employees										
Killed	487	472	463	390	289	409	1,124	1,153	709	842
Injured	3,007	2,946	3,181	2,724	2,076	2,953	4,349	4,017	3,436	4,080
Total employees on duty										
Killed	2,871	2,920	2,939	2,523	1,594	2,210	2,616	2,759	1,693	2,107
Injured	45,848	49,120	56,619	50,841	38,060	48,310	52,236	46,961	36,280	46,920
Employees Not on Duty										
Killed	292	315	362	327	215	303	165	169	66	91
Injured	954	959	1,178	1,097	840	811	544	595	321	314
Total employees on duty and not on duty										
Killed	3,163	3,235	3,301	2,850	1,809	2,513	2,781	2,928	1,759	2,198
Injured	46,802	50,079	57,797	51,938	38,900	49,121	52,780	47,556	36,601	47,234

*Year ending June 30th.

†Information not reported apparently included in "Road Trainmen."

was little influenced by schooling. Some of the highest records were made by men who had not completed the eighth grade. Those who were found to be the least intelligent proved also to be dull in the daily routine and were recognized as of too low mentality to be profitably dispatched overseas.

The results were so uniformly accurate and in agreement with the experience of the officers that they were quickly accepted and used as a basis for procedure. The work was repeatedly reviewed and investigated by the general staff and always approved, because it agreed with their

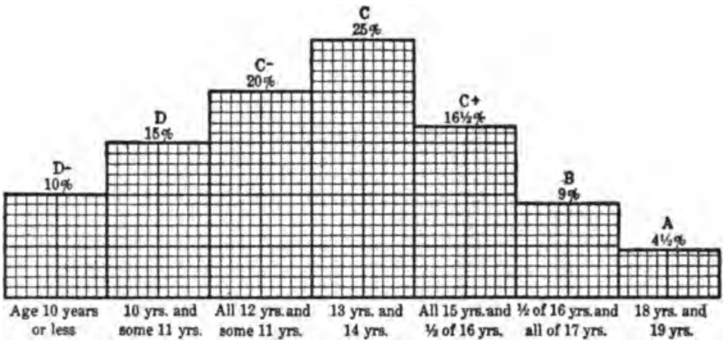

Diagram showing the mental levels of the United States Army as authorized and published under the authority of the Surgeon General of the Army.

The mental levels of the various groups of the 1,700,000 men taken in the draft and subjected to the intelligence test, are shown in terms of years. For example, 25% of such men had a mental level of 13 and 14 years, as shown under class "C"

FIG. 68.—DIAGRAM SHOWING MENTAL LEVELS OF MEN OF UNITED STATES ARMY.

experience with the men and furnished results much more quickly.

From an inspection of Figure 68, it will be seen that the men in the D minus group would have a mental age of 10 or less, the D group would be made up of some of 10 year and some of 11 year mentality; C minus includes the rest of the 11 year and all the 12 year; C is 13 and 14 years; C plus holds the 15 year and half of the 16; B is the rest of the 16 and all the 17; and, finally, the A group exactly covers the 18 and 19 year mentalities. The B group is of average

college intelligence. This shows at a glance the enormous proportion of the population of American that is of moderate intelligence. That the mental level of the average person is probably between 13 and 14 years explains a great many things not previously understood. It makes clear why it is so difficult to carry forward a great movement that appeals strongly to men of intelligence, but cannot be expected to appeal to the masses whose intelligence is lower than that of the "C plus" group, and it explains the easy success of the demagogue whose appeal is to the passions and is made with emotion and earnestness.

This review, abstracted from Professor Goddard's lectures on "Human Efficiency," is full of suggestions to the transportation officer. Has he the right proportion of individuals to do all the different kinds of work that are to be done, and is each man doing work of which he is capable? If the intelligence of the individual is below that required for the task assigned, he will be both inefficient and unhappy. The real solution is that the amount of intelligence required for the particular work should be ascertained and the degree of requisite intelligence that the individual has should be ascertained.

Figure 69 shows figures of "Wages" given out by the Department of Labor; "School" by the Department of Education; and "Intelligence" by the army. This parallel was not got up by any one person to prove a point. They are independent groups of facts, brought together for the first time by Professor Goddard to show the relation of intelligence as determined by the examination of the draft men to standing in school and in industry.

As soon as men began to congregate in groups, there arose at once the question of social adjustment and the problem has increased in complexity with every move which has tended to crowd individuals closer together; to be able to adapt oneself to all kinds of human beings is indeed difficult.

Of prime importance is learning or knowledge, that stock of experiences and general principles that enables the individual to adapt himself to all ordinary situations of life.

FIG. 69.—MENTAL LEVELS OF SOLDIERS, AGES AT WHICH CHILDREN LEAVE SCHOOL, AND EARNINGS OF WORKERS.

Intelligence Of 1,700,000 soldiers	School Of 100 children	Wages (1910) Of 100 wage-earners
10% in "D–" Group, Mental Age 10 15 " "D" " " " 11 20 " "C–" " " " 12 25 " "C" " " " 13, 14	13% Leave in 4th grade, Age 10 13 " " 5th " " 11 14 " " 6th " " 12 27 " " 7th & 8th " 13, 14	9% Earn $150–$200 12 " 250– 300 16 " 350– 400 31 " 450– 600
70% are below " " 15	67% Do not finish 8th	68% " less than $15 per week
16½% in "C+" Group, " " 15 9 " "B" " " " 16, 17 4½ " "A" " " " 18, 19	23% Leave after 8th 10 Attend H. S 3 Graduate H. S. 1.5 College	27% " $750–$1000 3 " $1250 2 " over $1250
Data compiled and issued by the United United States Army	Data compiled and issued by the United States Department of Education	Data compiled and issued by the United States Department of Labor

The energy of the individual is mainly a physical matter, a question of digestion and assimilation, heart activity and blood composition.

It is very true that "emotion" plays a large part in individual efficiency. Probably the largest element with the adult population is "a matter of habit." But fundamental instincts and emotions, as well as inherited temperamental differences, more or less independent, are nevertheless to a great extent controllable, and as to all it is the intelligence that is the final determiner.

It is the history of people of low mentality that they are constantly changing jobs, and in the railroad business their early elimination is most desirable. Those kept should be encouraged in self-control, surrounded by a favorable environment, and given careful training while subjected to constant supervision.

In a man's relations with his subordinates, it is essential that he keep constantly in mind that it is not a question of stature or age, but of mentality that determines an individual's conduct. The fundamental condition of winning a man to one's way of thinking is to convince him of one's friendliness and interest in his welfare. Lower intelligence will invariably and inevitably seek and follow the advice of higher intelligence so long as it has confidence in the individuals having the higher intelligence. It is the man whose activities show that he cares for the welfare and the happiness of those of less intelligence who has their confidence, their support and their obedience.

The really significant human relation is the relation of fatherhood. Here from generation to generation, not alone the physical conformation, habits and tastes, but mental attributes as well, mark the succeeding generations, and such is the span of life that not infrequently from grandfather to grandson are transmitted the lessons of actual, personal experience, which cover a span of more than a century. So significant a part is played by these relations of descent, that in the animal kingdom one cow sells for $50 and another for $50,000, that Man-of-War becomes the largest winner in the

history of the American Turf, with $249,465 to his credit in two campaigns, tracing back as he does in the direct ancestral line 250 years or more to his dam, Layton's Barbary mare, Violet, from whose female line, before the close of the nineteenth century, had come 7 winners of the Derby, 11 of the St. Leger, 11 of the Oaks, while 16 stallions of the same line were the sires of 21 classic winners, including the Doncaster, Goodwood and Chester Cups. Can any one suppose that, had Hugh Capet or Louis XIV been King of France, we should ever have had a French Revolution? It is true that Louis XVI bore the name of Bourbon, but he was not a true scion of his race. In his arteries flowed, not the blood of the Bourbons, with their genius, but, conforming to Mendel's law, he reflected at every movement the type and the character of his grandmother, poor Maria Leszinska.

It was fatherhood that determined the character of the descendants of Edwards and Jukes. In about 150 years the descendants of Jonathan Edwards numbered about 1400 persons. Among them there have been 120 graduates of Yale alone, 14 college presidents, over 100 professors: 135 books of merit have been written by various members of the family and 118 journals have been edited by them. Max Juke, born in 1720, was a thriftless truant, who married an equally worthless woman. Up to 1877 there had been five generations, with approximately 1200 descendants, among whom have been traced 310 paupers, seven murderers, 60 habitual thieves, 50 prostitutes, 130 convicted of crime, 300 who died in infancy, 440 physical wrecks from debauchery; only 20 learned a trade and ten of these learned it in prison.

Mental qualities are the dominant ones for humanity. There is an immense weight of probability that they are determined by heredity in the same way as any other characters of the organism.

260. The Personnel.—The efficiency of labor depends upon an effective method of management and discipline.

Sir George Findley, who spent most of a long life in the service of the London and Northwestern Railway and was for some years its general manager, wrote a book on *The Working*

and Management of an English Railway, in which he lays down that:

1. Every man should be chosen with special reference for the duties he is called upon to perform. There should be no "round pegs in square holes."

2. Care should be taken that every man entrusted with a responsible duty is thoroughly trained for its performance and competent before responsibility is cast upon him.

3. Every man should be fairly remunerated for his labor, and should be, as far as lies with the management to make him so, a cheerful and contented employee.

4. Every man should have his duties thoroughly defined, should know exactly what is required of him. "What's everybody's business is nobody's business," or, in other words, a piece of service which is equally the duty of two or three men is likely to be performed by neither, for each will shift it to the others if he can, and the one who ultimately discharges it will do so grudgingly, thinking the others might have done it rather than himself. Moreover, if, after all, it is neglected, it is difficult to fix the responsibility for the omission on any one individual.

5. There should be at all times active and vigilant supervision in every branch of the service. It is not enough that every man should be fit for his duties and trained for their performance, but it must be the duty of some one to see that he actually does perform them, and that no slackness or carelessness is allowed to supervene in carrying out the work from day to day. The railroad service is preëminently one requiring for its efficient conduct a high degree of smartness, alacrity, energy and zeal on the part of every individual engaged in it.

And the efficiency obtained is very high indeed. As Sir Daniel Gooch has pointed out:

Such a service cannot be carried on under all circumstances, whether by day or night, in fogs, in snow storms, in wind or rain, and all other adverse conditions, without entailing hardships and dangers upon the men engaged in the operation; yet this vast army of men of all grades employed in the services of the various railroad

companies exhibit at all times a state of complete discipline and cheerful devotion to duty, which could not be exceeded by any body of men whatever, and which, although perhaps not so well understood or appreciated by the public as might be the case, reflects the highest credit upon them.

Bearing in mind the vast importance of the interests entrusted to their charge, and the serious consequences that might arise from any carelessness or dereliction of duty on their part, the public may well congratulate themselves that their lives and limbs, their property and interests are confided to hands so trustworthy and reliable.

261. Employment.—I used to print in a box in one corner of the employment blank—

There are three ways to improve the character of the personnal:
1. Employ a better class of men.
2. Educate those kept.
3. Discharge the vicious and incompetent.

If I were to discriminate between these steps as to their relative importance, I should be inclined to lay emphasis on the last. Railroad employment is to a marked degree regarded as a protected service. Once a man's name gets on the payroll, he is hedged about by constant and numerous artificial restraints as a permanent fixture. In gardening it is not sufficient that the soil be good and well sustained by fertilizers and the seed the best. The resulting crop depends largely upon cultivation and weeding; and similarly in railroad service carefully selected men, education, and, above all, systematic and unwearied weeding is essential. Know your men, and those who from whatever cause are palpable misfits eliminate at once.

The greatest difficulty in securing competent help and in honest, capable workers, securing positions of trust exists in the very limited number of persons who may be known intimately by any one employing others in positions of responsibility. Many are in need of faithful and efficient help, many deserving workers need employment. Too often the trainmaster supplies himself with men by waiting until a head is pushed through the opened door of his office and a voice inquires whether he wants to hire a brakeman. That in itself

is sufficient explanation of many of the conditions of which so great complaint is made. The railroad should adopt a schedule of its requirements, in order to insure uniformity in their enforcement; the number of officers authorized to receive applications and employ men should be reduced to a minimum, and the employment records kept by these officers should be systematically inspected at reasonably short intervals by some superior authority or duplicates sent to some central office where they may be examined and checked. So far as possible, men should be employed from those living along the line of the road and the station agent should be the principal recruiting officer. Their moral character, physical fitness, mental capacity and education, and past record should be rigidly examined. Only the best and most suitable should be employed. For example, experience points to the conclusion that the man with a short back stands better the labor of firing and that the man of average size possesses the greater activity and endurance in the train and yard service. A waiting list sufficient to protect the seasonal demands should be maintained and, where preliminary instruction or training can be given, this should be done. It is quite possible to give the applicant for the fireman's job a good deal of preliminary training and instruction on the ash pit and as a hostler. The easiest place to educate a fireman is in the head brakeman's position. It is very desirable that some systematic method of handling the entire question of employment should be adopted and rigidly applied.

It is as much to the interest of the railroad as it is to the army or navy that men inducted into its service should be physically sound and the same careful physical examination should be made to eliminate bad hearts, weak lungs, hernias, color blindness and other prohibitive defects. This must further be considered in connection with the Workman's Compensation Law since these are not occupational defects.

We have sufficient cause for anxiety without being bothered with stupidity. The system known as the "Binet Simon," and used to determine the level of mental intelligence of men taken in the draft, might, it would seem, find applica-

tion in the railroad service. The chief criticism made of it was the emphasis laid upon the time factor, but here the railroad and army requirements are much the same.

Most men of the kind desirable for employment in train service are ready and fully able physically before they are 21. Where possible, there should be no hesitation in employing such men at 19. Very many of the men now in high official life entered as minors. It is a real hardship to youth and a serious injury to the community that the desire to "create jobs" has led to so much restrictive and ill-considered legislation on this subject.

The Biographical Directory of Railway Officials in America (1913) contains 4061 names. Of these, the date of birth or date of entering the railroad service is not shown for 311, leaving a balance of 3750 for whom such information is shown. The ages at which these 3750 officers entered the railroad service were as follows:

AGE AT ENTRY INTO SERVICE

Age	Maintenance		Transportation		Traffic		Executive		Miscellaneous		Total	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
6	...	.....	1	0.1	....	.....	....	.....	....	.....	1	0.0
10	...	.....	2	0.2	....	.....	...	.....	....	.....	2	0.1
11	...	.....	...	.....	....	.....	3	0.3	...	.....	3	0.1
12	2	0.3	14	1.6	2	0.3	6	0.7	4	0.6	28	0.8
13	6	0.9	24	2.8	24	3.2	12	1.4	6	0.9	72	1.8
14	16	2.6	70	8.0	34	4.5	34	3.9	12	1.8	166	4.3
15	16	2.6	72	8.2	54	7.2	78	9.1	32	4.8	252	6.7
16	36	6.0	98	11.2	92	12.4	100	11.5	56	8.5	382	10.2
		12.4		*32.1*		*27.6*		*26.9*		*16.6*		*24.0*
17	32	5.3	134	16.3	98	13.1	78	9.1	40	6.1	382	10.2
18	60	9.9	92	10.0	88	11.7	62	7.2	48	7.3	350	9.2
		27.6		*58.4*		*52.4*		*43.2*		*30.0*		*43.4*
19	54	8.9	82	9.3	94	12.5	56	6.5	60	9.1	346	9.2
20	44	7.2	78	8.9	62	8.2	76	9.0	56	8.5	316	8.4
21–25	264	43.2	156	17.8	154	20.5	180	20.9	148	22.5	902	24.4
Over 25	80	13.1	50	5.6	48	6.4	176	20.4	194	29.9	548	14.6
Total.	610	100.0	873	100.0	750	100.0	861	100.0	656	100.0	3750	100.0

The large percentage of officers entering the maintenance departments at 21 years of age and over doubtless is due to the demand for technical engineering education in such work.

The large percentage of officers classed as "Miscellaneous" entering the service at 21 years of age and over is due to the fact that in that class are included legal officers, most of whom probably attended law school before entering professional life. It is probably safe to say that the bulk of the 29.9 per cent of such officers entering railroad service over 25 years of age were legal officers who first engaged in private practice, later going into railroad service, or those having analogous experience. It is also likely that the entrance into railroad service of some portion of the 22.5 per cent of the officers entering service between 21 and 25 was delayed for the same reason, namely, they received a technical education or were first engaged in private practice. Giving due weight to these facts, practically 50 per cent of the executive officers of the companies, holding positions corresponding to officers in the army, entered the service at 18 or below.

One may well have misgivings that our present custom of getting them so matured is a bad one when such magnificent results were produced by "getting 'em young."

262. Continuity of Employment.—It is of the first importance to both the company and the men that employment should be continuous. The men should be taken into the service at as early an age as is compatible with the service. Great care should be exercised in their selection. Their moral character, mental qualities, physical condition ought to be considered, and, where possible, preference given to men with home attachments in the territory served by the company. Once placed permanently on the roll, every effort should be made to insure permanent retention. The first six weeks of employment are usually the critical period. The world into which they are introduced is a strange one. The fellowships and clannishness of the men; the novel relationships and obligation; the language filled with new terms and a new slang; the speed with which matters move and the wide extent of the territory covered, all combine to confuse and disconcert.

During this period the recruit should be kept under the watchful eye of his immediate superior, frequently counseled and encouraged, until he begins to get his bearings, to know his way about and become adjusted to his new environment. If he lasts through the six weeks he is likely to become enamored of the life and, whether or not he remains definitely with his first employer, he is not likely to quit the business.

Then should begin patiently and systematically the instructions designed to fit him for the discharge of the duties assigned him and to enable him to take promotion as opportunity offers. After two years' service the employee may be regarded as a permanent member of the force. This education is a costly process paid for often in delays, in minor breakdowns, sometimes in costly accidents. It used to be said that to educate a locomotive engineman cost the company $5000 and Addison Hills, the Vice President of the Lake Shore, told me in 1886, he thought it cost that company one million dollars to educate a general manager. "Firing" is a thing an intelligent officer is loath to do. The educational process imposes such a burden upon both the company and upon him as to prohibit, except when unavoidable, the engaging of new men and consuming of time in their education. The men leave for a great variety of reasons, for the most part inherent in human nature.

As far back as 1361, we find that among the tailors of Silesia the system of journeymen traveling in search of work was already completely organized. The man, having learned a trade, set forth on a journey to see the world, to broaden his experience and widen his vision, continuing this course until he lost interest, some particular attraction held him or he became anchored through marriage. Beyond question this was a benefit alike to the trade and to the race. Like the young tree that in the nursery is transplanted three or four times before being set in its permanent place, every man who can will do well to endure the test of maintaining himself under new conditions and among strangers. The cultivation of adaptability and the hardening of his fiber will be very evident. The two great assets are self-knowledge and self-

reliance, and it is under these conditions that he comes early by them. How often we find among these men a great fund of common sense, that power of knowing or hitting the mark as to things and ideas, the impression of the real, cautious, critical, shrewd and well-balanced, a sort of curb and correction of the errors that education and history so often produce. Against pursuing such a course too far, we have the warning adage "a rolling stone gathers no moss."

Many men have difficulty in finding an attractive and useful occupation, and if they have sufficient initiative make several moves in the effort to find one. Others yield to the lure of a new environment, family connections, the attractions or difficulties of climate, and some are afflicted with "wanderlust," a mighty voice which in a powerful language influences alike man and beast and the fowls of the air.

I think it is safe to say that in normal times 20 men leave the railroad service of their own volition as against one discharged by the authority of the officer, and those who leave do so as a rule early in their term of service.

In times of extraordinary business activity much is said about the so-called "labor turnover." Even when in excess of 100 per cent, it is not, as seems to be sometimes assumed, a turnover of the entire force. It is confined largely to a few positions in the organization and marks the continual coming and going of a mass of restless, discontented, unfitted men who fill for the time being, relatively few places, while the great body of the personnel remains unchanged. It is chiefly a phenomenon of flush times and the result of an effort to employ the unemployable.

There were on the payrolls of the Delaware and Hudson Company as of December 31, 1921, a total of 13,111 names. Of these, notwithstanding the readjustments made necessary by the war, 10,554 names showed a service of more than two years (interrupted in some cases only by the war) as shown in table on following page:

Of the foregoing employees 34 had been in the service of the company 50 years or more. Of those in service less than two years, 2379 had been in the service more than six months.

No method should be left untried, no effort neglected to place and keep the relations of the men and the management upon the best and most stable basis. He who does not foresee conflict, provokes it; to withhold means of preventing it is to doom it to greater violence. Even-handed justice, strict discipline, orderly administration, a sympathetic attitude and kindly interest will go far.

	Total Number on Payrolls	Number in Service Two Years
Group 1. Executive and general officers....	180	180
2. Other supervisory officers........	18	18
3. Foremen........................	763	700
4. Train dispatchers...............	36	36
5. Agents.........................	213	200
6. Telegraphers...................	278	225
7. Clerks.........................	1,782	1,400
8. Train crew, engine crew and hostlers	2,344	2,200
9. Motive power..................	3,075	2,400
10. Car department................	1,267	1,000
11. Store department..............	35	35
12. Maintenance of way............	2,388	1,600
13. Police department.............	107	90
14. Transportation department laborers	424	300
15. Cooks and waiters.............	59	50
16. Building employees............	142	120
	13,111	10,554

But man in whatever circumstances he may be placed is a dissatisfied being. It is not to the interest of the race that he should be content to be content. Next to the sexual instinct and hunger this feeling of dissatisfaction is perhaps the most powerful of the forces that move him. Kept within its proper bounds it has gained him his advances from barbarism; given a loose rein, it will let him run wild to savagery. Its possession makes him an "easy mark" to the skilled agitator and the demagogue who would use him for their own selfish purposes. Against such organized dissatisfaction many plans have been formulated and tried. Many have had their root in philanthropic motives and recognition of human obligation.

But important as these are, they are not so important, nor can they take the place of that personal equation that comes only from close association and fellow feeling. This is of the first importance to cultivate.

263. Training and Instruction.—With his induction into the service should begin the systematic instruction of the employee in his duties, the use of the appliances he must handle, the observance of signals, the rules of operation, the filling out of reports, etc., etc. There should be examinations at regular intervals to test the knowledge acquired, to disclose failure in attainment, and to direct attention to weakness needing strengthening. Some of this work must be repeated at intervals all through the employment period. Much more should be done than is done in stimulating interest and giving opportunity for experience, especially in those who show capacity for advancement. Practically all those holding official positions are moved along from one post to another, beginning at the bottom. There is now, of course, a very great amount of instruction given in the rules, the signals, the air-brake, to the special apprentices, etc. Teaching of this kind, not only by the railroads, but by industries also, forms a very considerable part of our general system of education. But much more, I am sure, remains to be done. I think it would be to the interest of some of the larger companies to establish at some central point on their system a technical school, to which men might be sent in two reliefs, say for five and a half months each and for two calendar years for each man. Here might be taught the elements of physics, chemistry, electricity, heating, lighting, lubrication, accounting, operating practices and kindred subjects bearing upon the daily work. And here might be kept a general and technical library for circulation among the men and from here too there might be conducted a correspondence course both for the students temporarily back on the road or permanently returned to it, and for those to whom circumstances did not permit attendance at the school.

It is to the interest of every man to devote some portion of his time to the practice of reading, writing and the general

improvement of his mind. A canvass of the officers of one of the larger railroads, in 1921, indicated that 46 per cent did no reading; 40 per cent read only technical journals or books, and only 14 per cent read systematically to broaden their general information. There are several thousand languages used by the human race, divided among some 15 to 20 types, including the click-click group of the Hottentots and allied tribes. In the small countries of Europe, where a few hours' run of a passenger train will take the citizen into a foreign country with a strange language, the children in the schools are taught generally their own and two foreign tongues, but in the United States and Canada, where one may make a continuous journey, from Key West to Prince Rupert, traveling eight hours a day, of 21 days, and meet only by accident a person speaking a foreign tongue, such linguistic ability has but little if any value. On the other hand great attention should be given to teaching the foreigner and particularly to perfecting ourselves in the correct, precise and definite use of English. Many of our words have many meanings and shades of meanings. If you heard a man speak the word "spring," could you know whether he meant the vernal season of the year, the flow of water from the hillside, the act of a boy in leaping from the ground, the shape the tailor gives to the bottom of the trouser leg, or the resilient device used to absorb a shock? And our grammar, too, has many pitfalls. If you heard a man say, "I have rented the house on Main Street," would you be certain whether he had become a landlord or a tenant?

It is, therefore, to my mind one of the most important things that a transportation man can do, that he drill himself in the correct, precise and definite use of English. Nor should he regard this as a hard thing to do. In using 100,000 words in household correspondence or in the news of the newspaper, one-half of the words consist of the repetition of the 50 following words in the numbers indicated.

It will be noted that with the exception of the word "very" these words are all of one syllable and that they convey but the one meaning:

the	6393	with	822	me	444
and	3438	be	816	so	432
of	3422	your	793	one	428
to	3217	at	698	if	408
I	2387	we	695	they	400
a	1911	on	667	had	397
in	1904	he	619	has	391
that	1422	by	611	very	383
you	1306	but	572	were	368
for	1241	my	557	been	370
it	1197	this	551	would	362
was	991	his	543	she	359
is	931	which	540	or	348
will	873	dear	523	there	341
as	854	from	488	her	311
have	846	are	468	an	296
not	831	all	448		

The English language contains approximately 400,000 words.[1] The Bible makes use of from 10,000 to 12,000 words and Shakespeare of about 15,000 words, and the vocabulary of the average educated person includes perhaps 6500 words. We employ in the conversation with which we conduct the ordinary intercourse of life only about 4000 words and the most of these present no difficulties. The same may be said of the perhaps 1500 words used in speaking of the various appliances and practices used in the railroad business. Thus the problem is greatly simplified.

I would urge, then, that you do two things:

First, that you do not take for granted in the discussion of matters of importance that you understand what is said to you, but that you endeavor to have the subject presented in other forms so that you make sure of a correct conception, and, conversely, in giving instructions or information, that you amplify them with some further explanation of your meanings.

Second, that you watch carefully to see what words are used that leave doubts in your mind as to the idea intended to be conveyed and each night look up in the dictionary five

[1] *Growth and Structure of the English Language,* by O. Jespersen.

such words, if there were so many, and inform yourself fully as to each. Also make a lead pencil check on the margin opposite such words and occasionally review them to fix their meanings in your memory.

I fancy there is nothing that would remove so many of the difficulties of our living together in amity as precision in our use of language.

I was much struck at the meetings of the President's War Labor Conference Board (in March, April and May, 1918) by the insistence of the representatives of labor that because the employers' group conceded "the right of collective bargaining" they thereby committed themselves to its practice and were guilty of bad faith in their insistence that they were reserving the right to deal individually or solely with their own employees. It was urged by the employers in explanation that to concede the right of the man Brown, being a bachelor, of suitable age and in good health, to marry the woman Smith, in no way committed her to the matrimonial alliance. She was quite free to wed Jones or to remain single as she might elect. But, put forward as many examples as were possible, argue the question at length, nothing removed the misunderstanding. Assuming that the labor leaders were contending in good faith, they seemed hypnotized by a phrase; having given it one interpretation, their minds could not receive another. They could see only one meaning of the word "right"—that of "possession"; that the word "right" also had the meaning of "a course of conduct" they could not bring themselves to conceive.

It has been said that "the world of letters is the world of the wolves." As you must spend so much of your time in that world, go well armed and be always alert. There, on the other hand, you will be assailed with many speeches and much writing, for the most part made up of imposing sophisms, beautiful expressions and intense fervor, all handled with so admirable an art that you are made to feel that now for the first time truth itself is revealed. These are the expressions peculiar to men who have handled ideas without ever coming into contact with realities.

On the other hand, you will be assailed by the activities of men having great power through their control over large numbers of men, in constant and direct touch with realities, the realities of one side only of the problem, who have almost no ideas and even less of ability to look ahead. The wolves could do you no more harm than these men, were you to fall into their power. You may read Rousseau and believe that "Man is good," but if you rule your actions by that belief, your head will fall like that of Louis XVI under the ax of the guillotine. And when men are in the mass, remember that nothing so excites the passions of the mob as words they do not understand.

264. Discipline.—The most that can be done by management is to lay down certain rules and principles and extend by every means its oversight and control. Mistakes of various sorts may appear more quickly, but the results of improper or hasty administration of discipline are inevitable and far reaching.

It is impossible to keep house without breaking dishes. While the company risks the property and money, the men risk their limbs and lives. The officer must protect all, and he must especially charge himself with the protection of the men from each other. The men are away from their families a great portion of their time, depriving them of their protection, and many of their fellow employees have knowledge of their whereabouts. The officer must fully appreciate and discharge his own responsibilities under these conditions. Fortunately the standard of morality is very high.

Not only will uniform discipline relieve the men of what is a serious grievance—the difference in treatment at the hands of the several superintendents of a property—but a guide is provided as to what may be reasonably expected under the varying conditions. Too many officers seem willing to forego their chances of success for the chance of being liked. Discipline, to be effective, must be prompt, certain, reasonable, impartial, uniform, dignified, severe enough to be felt, and of lasting benefit.

Lack of uniformity in discipline and treatment promotes

the growth of labor organizations. Nothing is a greater breeder of discontent than constant nagging and repetition of short suspensions. While it is important that the officer cultivate his capacity for observation, he should cultivate also his judgment so as not to see too many things. The exigencies of the service present constant opportunity for the exercise of good temper, patience and common sense. Officers should cultivate these qualities and to this end observe a civil bearing, quiet, dignified and manly, and accord respectful hearing to all communications properly addressed. Duty thus discharged will command the respect of all the well disposed.

Watch always that the witness speak not only the truth but the whole truth and nothing but the truth. Watch that he does not enlarge on the facts; exaggeration is more dangerous than falsehood, being the addition of a falsehood to truth. It is difficult to detect and to separate that which is exaggerated from that which is strictly true. On the other hand everything suppressed is short of the whole truth. It is astonishing how seldom we find a really accurate observer and still more rarely one with an accurate memory. Under examination almost always one of three prime defects are disclosed; they report what did not happen; they do not report what did happen; they report events in the wrong order. Submit yourself to a simple test. You have doubtless handled a pack of cards many thousands of times. Which and how many of the kings look out at you with both eyes, and similarly with but one eye? We see but we do not observe.

When I was division superintendent, I used to take care that all members of the crews involved in an accident, as well as any others who might be involved or have helpful knowledge, were present at the investigation. Separate and apart they were examined, one by one, to assemble all ascertainable facts, and care was taken to let the facts tell their own hard story. The whole matter was then discussed with the trainmaster, road foreman of engines or with such other officials as might be present. The cause of the accident and the relative responsibility therefor were determined; the character, fitness and past record of the men discussed and the discipline agreed

upon. All were then called into the room, the case explained in detail, an effort made to enforce the lesson to be drawn and to avoid a recurrence, and the discipline of the brakeman or fireman or whoever it might be announced. The room was then cleared of all but the enginemen and conductors and the discipline in their cases announced.

What could be done was done to give dignity to a serious business and to avoid violence to the self-respect of those in responsible positions. Nothing so angers a man as to be treated with disdain, nor does anything more surely wound him, for men see all too clearly that arrogance is often the mask of incapacity. One should have in mind the admonition of the ancients: "Take care always to remember that you are a judge and let every action be done with perfect and unaffected gravity, humanity, freedom and justice."

In the early railroad practice, punishment was imposed in the form of fines; later these fines were credited to a fund from which payments were made to employees brought into conditions of distress; and still later, because of the attitude of the brotherhoods, the system of fines was abolished and suspension substituted.

In the late 1880's, George R. Brown, General Superintendent of the Fall Brook Railroad, put in force a system intended to improve discipline by recording demerit and merit marks, accumulating to a total that indicated, in the case of the former, discharge, accompanied by bulletin board notices giving explanations of causes of accidents and resulting discipline, omitting names. As the Brown system came to be adopted by one line after another, a general discussion arose as to its merits. Some years after it had come into vogue, I expressed an opinion that subsequent years have confirmed. "The arguments for Brown's system are very attractive but I do not believe the method is adaptable to this wicked world. You may catch flies with molasses but mankind is differently constituted. Next to the influence of the labor unions I think the greatest element in the general let-down of discipline so manifest of late years is the general use of Brown's method. The records of course should be kept. They were kept on the

better properties long before this system was heard of. My experience is that the bulletins soon cease to be read by the men. If the investigations are properly conducted, with all the men of the crews present when the finding is announced, and pains are then taken to draw and enforce the lesson to be learned therefrom, I believe, in the long run, much better results are obtained with the present practice. As to punishment, I do not see how we can safely eliminate it and in any event the gap is wide between chiding and suspending or dismissing."

You may be familiar with the story of the English schoolboy, who, being asked as to his head master, replied: "He's a beast, but he's a just beast." The saving grace in the administration of discipline is painstaking justice.

What the officers must keep in mind is that, quite aside from their relation to any specific rule, there exists among the mass of men a strong desire for "liberty" which to them means the power to do what they want to do, and this desire cannot be dealt with in terms of reason. The men may be looked to, to strive to give expression to their *will*, the officer must find the means to give expression to his *judgment*. The most powerful instrument that he can use and the one upon which he must rely is a just but inexorable strictness.

It is much more important to watch the "bad-order" men, than it is to watch the "bad-order" cars. As in the case of the latter, so also in the case of the former. If you keep the number down to 5 per cent, they are not likely to be more than an annoyance, but if you permit them to accumulate to 10 or 12 per cent, they are likely to ruin you.

265. Suggestions for Uniform Discipline.—No greater safeguard against errors may be devised than to insure reasonable uniformity in discipline in all cases where investigation has shown the facts to be the same (the infraction and not the consequences that may have flown from the infraction, is the thing to be considered). There is no division superintendent, no matter how great his experience, but would be materially assisted in this important part of his work, and no employee but would do his share more cheerfully, with the

certainty of being treated the same as his fellow employee under the same conditions (the modification due to past record being made clear). To this end the following routine was adopted on the Pennsylvania Lines while I was general manager; it was, I am told, regarded by the brotherhoods as "mild discipline":

Reprimand.
Suspension from duty without pay.
Definite and irrevocable discharge from the service.
Suspension to be for one or two weeks, 30 or 60 days.
Careful individual record to be kept.
The brotherhoods to be held to the enforcement of their rules for the violation of Rule G (intemperance).

One week
- (*a*) Running through switch improperly set while going to or from siding, shifting or making up trains.
- (*b*) Carrying car by destination.
- (*c*) Failure to report defects in engine.
- (*d*) Violation of rule 114.
- (*e*) Missing run.
- (*f*) Running by signal at flag station.
- (*g*) Conductor signing order for engineer, or vice versa.
- (*h*) Rough handling of passenger train.
- (*i*) Honoring improper transportation.
- (*j*) Failure to take cars as ordered.

Two weeks
- (*a*) Delaying passenger train by being late in reporting for duty.
- (*b*) Not putting cars into "clear."
- (*c*) Pulling down standpipe.
- (*d*) Failure to register.
- (*e*) Telegraph operator asleep on duty.

Thirty days
- (*a*) Leaving main track switch improperly set.
- (*b*) Running on time of superior class train.

Discharge
- (*a*) Intoxication on duty.
- (*b*) Incompetency or unsatisfactory service.
- (*c*) Burning crown sheet.

These are to be considered as suggestions only and not as arbitrary rules. On the one hand, where great negligence is

shown they should be increased and, on the other, where the staff record warrants or where mitigating circumstances are disclosed, they should be reduced. They are, however, to be considered generally as minima and any departure therefrom should be accompanied by reasons for so doing. Very great hardship may be suffered by men subjected to very long suspensions. There should be no discipline by reduction in rank, nor by transfer in service, nor should there be reëmployment after discharge.

The amount of ignorance that is sometimes found among engine crews and train crews as to their duties is appalling, and much instruction is necessary to bring them to proper condition. Case after case of accident reveals ignorance of the workings of the interlockings, of the air brake, of the train rules, and the handling of the locomotive. In all such cases before the man is returned to service he should be instructed and examined. This is as much to the interest of the men themselves as to that of the company.

PART VII

MEN—SECOND SECTION

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266. Railroad Provident Institutions.—From the early days of railroading the primitive subscription paper circulated among the friends of those needing aid and was usually supplemented by appeals to the management of the property. Before the establishment of the relief association there was hardly a case of sickness, accident or death, where the fellow-members of the division or the department were not called upon, or at least expected, to make a contribution towards its relief.

The mutual benefit associations and fraternal organizations among the employees that followed, in the great majority of the cases rising and flourishing for a time, were found to lack the elements of stability and permanence. First of these would appear to have been the "Old Reliable," an insurance organization established by conductors in 1868. It is on record that in a comparatively small portion of the country, more than 400 of these and kindred associations failed and were wound up within the short period of eight years. Great injustice resulted to those members most faithful in the support of these organizations. Paying maximum contributions, by reason of long continued membership, they received minimum benefits, the result of reduced membership in the later years; or nothing at all when at last the institutions were closed up. Manifestly something more permanent and reliable was a necessity.

From a very early period measures were taken by interested officers in the railroad service, in many cases involving

the financial assistance of the road itself as well as the service of its management and the use of its property, for the betterment and general care of the employees. There resulted certain institutions which came to bear the technical name of "Provident Institutions." These were taken over by the railroads in the belief that closer and more intimate terms might be cultivated with the employees, improving and bettering their condition and firmly uniting their highest interests with those of the company. These provisions, so evidently actuated by truly human purposes, have been largely followed by manufacturing and other forms of industrial enterprises. They affect directly and largely the comfort and well-being of the men and undoubtedly promote *esprit de corps*, but they have not in themselves been enough to attach the men to interests and welfare so truly their own.

The first formal organization of this character appears to have been instituted on the Baltimore and Ohio Railroad on May 1, 1880. It was largely the creation of Dr. William T. Barnard, who brought great enthusiasm to the service, and gave careful study to the practices abroad and to their application here. He was a pioneer in a service of great beneficence. It was succeeded on April 1, 1889, by the organization of the plan now in operation on that system. This original organization was followed by that of the voluntary relief association of the Pennsylvania Railroad Company on February 15, 1886, and these two have served as models for like undertakings by other roads. Where such organizations are handled with liberality and skill they can be made to embrace about 70 per cent of the employees, which is perhaps all that can be expected considering the seasonal nature of much of the traffic and the consequent fluctuations in the forces.

Provident institutions take the form of:

1. Insurance and relief provisions.
   (*a*) Employees' Mutual Insurance.
   (*b*) Employees' Relief Association.

Associations of this character in considerable number have been at various periods brought into existence, sometimes on

one road, sometimes on a group of roads, and sometimes for one type of service. When organized and managed by employees alone they have, for the most part, been short-lived, lacking the numbers necessary to furnish the distributive protection relied upon by insurance companies and because of the lack of financial responsibility, resource and experience of the employing organization.

(*c*) Life, accident and sickness insurance.
(*d*) Endowment insurance.
(*e*) Railroad relief department.

These organizations formulated and managed under the auspices of the railroad companies all follow the same general plan, based upon the experience of the great insurance companies and working in accordance with their actual system. They are provided with ample reserve funds; the expenses are low and usually paid by the railroad companies. There are, I think, some institutions that provide for:

2. Those with pension or retirement provisions.

As a rule such provision on the railroads in this country is made by the company at its sole expense.

3. Those with unemployment provisions.

The superintendents of insurance of the several states have generally opposed laws providing for unemployment insurance as likely to create unwholesome conditions.

The five major hazards of life, which are the cause of apprehension and anxiety to the workman, are death, accident, sickness, unemployment and superannuation. Four of these are provided for by forms of insurance issued by insurance companies. Of recent years there has developed a group plan of insurance under which the loading or overhead expense has been much reduced by elimination of physical examination, solicitation and collection, but the cost for annuities is very heavy, and, as stated, the insurance companies are not permitted to insure against unemployment. On January 1, 1922, the Delaware and Hudson Company inaugurated a policy to

cover these five hazards as a protection in tempering unexpected, often cruel, blows from fate.

For this purpose unemployment was defined as being out of work because of the action of the employer, and relief was extended for a period of six weeks. Such a feature will greatly increase the independence of the employee and, paradoxical though that may seem, I believe will correspondingly attach him to his job.

It will be noted that three of these hazards are definite, but great difficulty is experienced in dealing with sick and accident benefits. Malingering is a recognized drain on the existing relief funds and, before the World War, threatened in the opinion of some authorities, to break down government insurance in Germany.

The failure of the working people, who are in the best position to know the facts, either personally to assist public officers, or, by creating public opinion, to control conditions of which they complain, is the explanation of many disappointing failures and well-meant efforts at relief in this field.

4. Savings funds.
5. Loan provisions.

In most institutions the deposits in the savings funds are treated like those in a savings bank, interest thereon being paid the depositor and the principal invested in interest-bearing securities, and sometimes in loans to depositors.

On the Baltimore and Ohio Railroad loans are made in multiples of $100 upon first mortgages to the amount of three-quarters of the value of the property, counting in the valuation of the buildings erected. Repayment is made in the amount of one and one-half per cent monthly and interest is adjusted on each payment. This liquidates the loan in 82 months. The total interest paid on an advance of $1000 in this period of six years and ten months would amount to $219.43, or at an average rate of 3.21 per cent per year. In 1903 the Baltimore and Ohio had out on first mortgage $1,207,078.06, used in building 1505 houses, in the purchase of 1942, in the improvement of 443 homesteads, and in releas-

ing liens on 1135 properties. In 1920 the Baltimore and Ohio employees in the number of 10,201 had on deposit $11,087,158, of which there was out on first mortgages $5,987,989.47, in loans to 5696 employees, on real estate representing homes purchased, built or improved. During 1920 payment was completed on 942 homes and 1405 new loans were made. Since the inauguration of this institution loans have been made on over 21,000 pieces of property, representing more than $30,000,000.

Many railroad officers have been profoundly discouraged in work of this character because of the attitude of some of the men and particularly because of the attitude of organized labor. It is, however, a field of vast possibilities and should receive encouragement and hearty support, both in the disposition of individual funds and in the use of the joint resources of the companies and the employees. If all these activities were gathered up under one department head, say an assistant to the vice-president in charge of operation, and the incomes intelligently used, particularly as has been done on the Baltimore and Ohio Railroad, where to an extent not known on any other road the employees own their own homes, the savings of the employees and the contributions of the companies would accomplish manifold purposes. There would be added to saving and insurance the provision of a home for the family, the unit of civilized society.

Second only to this should be the encouragement and aid given to the employees to become proprietors in a business of which they are a part through the acquisition of corporate stock.

6. Coöperative capital stock scheme.

This plan provides for employees becoming stockholders and sometimes has besides the characteristics of the ordinary savings fund.

The relations between employer and employee have been so much discussed of late years that I may be pardoned for again referring to one aspect of the question frequently urged, namely, the participation of the employee in the functions

of management. It was a wise old saw that "when two men ride a horse, one must needs ride behind," and I have never seen any way suggested to get around that rule which seems workable. The management should manage and the men man the railroad, and this line should be sharply drawn. To my mind the place to look for a voice in the affairs of a company is in the corporation itself. The business corporation is merely a form of association for the purpose of conducting business. The development of mechanical production made necessary the utilization of the capital of very many individuals under a single control. The emergence of this necessity was the imperative demand for a new type of association, and pointed at once to the deficiencies of the only form of combination then known, the partnership, and to the new requirements of the new industrial methods. The corporation swept away the personal relation, the hazards of dissolution, the necessity for unanimous consent, the ability of one to speak for all and by his separate action to control and imperil the joint assests. It enabled large numbers of individuals to combine their capital for single undertakings and insured its continued existence. It required the concurrence of a majority but made that majority's voice effective, and gave a voting power proportioned to the respective contributions of capital. It was not a thing springing fully developed from the mind of any man. It is an evolved product of necessity; it is what it is because its every attribute was and is necessary to industrial efficiency. No nation, whatever its system of law, has ever enjoyed great industrial expansion until it has met this necessity by developing a method of association similar to the business corporation as we know it.

Moreover, it lies within the potentiality of this device of association, the business corporation, to make industry, so far as it may be, democratic; for this method of association is the means by which those whose savings are the smallest can yet become participants in industrial enterprises organized upon the largest scale and can share the profits of industrial processes that require the most costly plant and

machinery. Without this method such enterprises would be closed to all but the owners of vast wealth. As it is, whoever can accumulate even as much as a fortnight's wages of an artisan may, with his savings, become a part owner in almost any great undertaking, and thereafter the labors of its directors and officers in whose choice he has a voice will be in part for his benefit. Thus this modern method of association places at the service of those of the most modest accumulations the skill, training, and genius of the relatively small but highly efficient group of men whose leadership in matters of finance and industrial management has emerged as naturally from controlling economic conditions as has the corporation itself. This opportunity for safe and profitable investment is at once a stimulus to frugality and an incentive to the employment of accumulations which, if made at all, would in the absence of such an incentive, be hoarded.

No substitute for the corporate method of association which does not involve the abandonment of the institution of private property has ever been suggested or devised. When the organization of industry loses its efficiency, disaster must come. There cannot be, without the risk of economic disaster, any crippling of the only effective system that human experience has yet devised for utilizing, in combination with modern discoveries and processes, the capital of large numbers of investors, large masses of labor applied under the best practicable conditions of comfort and security, and directive ability of the highest type. If such impairment could ever be risked with impunity, it would be especially injurious at this moment on account of the numerous doubts and difficulties which now, let us hope temporarily, confront the people of the United States.

In connection with the many references of late to "industrial democracy" and the frequent demands being made by labor for participation in the management of industry, the following is an interesting example of how such participation can be secured through avenues widely different from the "Plumb Plan" or other labor union proposals:

The United States Steel Corporation was organized in

1901. On December 31, 1902, it announced and put into effect a plan whereby its employees were encouraged to invest a certain percentage of their annual wages and salaries (the percentage being based on the amount of such wages and salaries) in the stocks of the steel corporation at varying prices, depending upon the market prices of the period. As an inducement to do this and to aid them in paying for the stock, they were to receive, in addition to the regular dividends, a further sum of five dollars per share per year for five years following the acquisition of such stock, provided they did not dispose of the same.

The average annual market price of the preferred stock varied from 70 in 1903 to 119 in 1916, and its full seven per cent dividend has been paid without interruption since the organization of the corporation. The common stock varied in average annual price from 21 in 1904 to 108 in 1917. No dividend was paid in 1904, 1905 and 1915, but with the exception of these years dividends have been paid each year varying from 1¼ to 16¾ per cent.

If the employees each year had taken 10 per cent of their annual wages, together with the dividends received from the common and preferred stock previously acquired (but not including the extra payment of five dollars per share) and had invested sufficient of this annual amount in the seven per cent preferred stock to secure a four per cent return upon the total amount invested for the year, the surplus remaining could then have been invested in the common stock. In this way they would have been assured of at least a four per cent (or savings bank) return on their current investment, and would have had, in addition, the sums received in dividends from the common stock purchased.

If this practice had commenced in 1902, the employees would have acquired by the end of 1905, or within four years, 309,682 shares of preferred and 1,032,203 shares of common stock, or a total of 15 per cent of the outstanding shares, sufficient under the usual practice to entitle them to representation on the board and a voice in the management of the business.

By the end of 1912, or within 11 years, they would have acquired 1,410,120 shares of preferred and 2,333,924 shares of common stock, or 43 per cent of the outstanding shares, thus giving them practical control of the business.

By the end of 1918, they would have acquired all the 3,602,811 outstanding shares of preferred stock, and 4,311,974 common shares out of 5,083,025 outstanding, or a total of 91 per cent.

At this rate, during 1919, they would have acquired the remaining common stock, resulting, within 18 years, in the purchase of and full payment for all the outstanding shares of both issues of stock, through the investment of 10 per cent of their wages and the dividends received thereon.

As a matter of fact they actually did subscribe, from 1903 to 1918, inclusive, under the plan put into effect by the corporation in December, 1902, for 355,222 shares of preferred and 364,690 shares of common stock, or eight per cent of the total shares outstanding, though, of course, it is not at all likely that all the stock so purchased is now held by the present employees or has even been retained by those originally subscribing for it, whether remaining in the employ of the corporation or not.

The foregoing is of interest in view of the increasing demands being made by labor, and by others in the interests of labor, not only for a larger share in the *profits* of industry but for a voice in the *management* of industry. If labor is sincere in its desire for such financial and managerial participation, and is willing to purchase it by thrift as most of the present-day stockholders have had to do, this is an example of what can be done in the way of securing democratic representation in corporations by saving and investment. It has at least the great merit of common honesty.

There is another and much more powerful reason why employees should become stockholders in the companies for which they work. They need assistance to establish the habit of saving and they can secure this through the company and in a manner peculiarly adapted to their necessities. In the discharge of their obligations to their children and to society,

and we hear much now of "social duties," they are under obligations to make substantial contributions to the capital fund.

7. Hospital service, including railroad hospitals, contract hospitals, emergency stations, dispensaries, first aid classes, ambulance classes and crews, and hospital cars.
8. Leave allowances.
9. Young Men's Christian Associations and Railroad Barracks.
   Library and reading rooms.
   Literary institutes.
   Miscellaneous provisions—rest rooms, dining clubs and other minor provisions.
10. Welfare work.
    (*a*) Physical welfare, including provisions for cleanliness, pure drinking water, proper toilet rooms, ventilation, light, separate lockers for outdoor clothing, dressing rooms, etc.
    (*b*) Recreation, including gymnasiums, athletics, indoor and outdoor, club houses with rooms for dancing, entertainment, and games, annual picnics, annual dinners, orchestras, prizes for flower and vegetable gardens, Christmas and vacation funds, etc.
    (*c*) Homes, including good drainage system, supply of pure water, good paving and curbing.
11. Public and private (outside) provisions.

Endowment provisions by private persons on behalf of railroad employees have been considerable, both in number and variety.

I shall mention only three that have come under my personal observation and that have been found to work with much beneficence:

267. *John Edgar Thomson Fund.*—John Edgar Thomson was President of the Pennsylvania Railroad from 1852 until his death in 1874.

It was his wish to devote his personal fortune to some end, helpful to those dependent upon the calling in which he spent the greater part of his own busy life. After careful consideration he decided that he could do no more useful service than to make provision for young girls who, by reason of the deaths of their fathers in the performance of rail-

road duty, might be in danger of losing the advantages of home and schooling. Mr. Thomson left for this purpose his entire estate of approximately $1,500,000. By conservative administration this fund has been increased until to-day it is $2,143,329.57.

At present five ample dwelling houses on Rittenhouse Street, Philadelphia, are occupied by 45 girls, and in the summer a roomy, comfortable country house at Elberon, N. J. Besides school studies, each girl receives a practical course in domestic science, including cooking, sewing, laundry work, and housework, taught by four experienced instructors. It is more than a school. It is a family of 45 bright, wholesome children under the care of a few adults, all living a genuine, happy home life.

268. *Frank Thomson Scholarships.*—Frank Thomson was the President of the Pennsylvania Railroad Company from February 3, 1897, to June 5, 1899. His children, Anne Thomson, Frank Graham Thomson, and Clarke Thomson, in 1907, established a trust fund of $120,000 in memory of their father, the income of which is applied to afford the sons of living or deceased employees of the Pennsylvania Railroad opportunities for technical education, to enable them to qualify themselves for employment by the Pennsylvania Railroad. A scholarship income grant for four years, payable quarterly, is made to eight holders who may each select the college or technical school that he prefers to attend. In the past 13 years, 28 boys have enjoyed these benefits, matriculating at 15 different educational institutions.

269. *Oscar G. Murray Fund.*—The Oscar G. Murray Fund is the residue of the estate of a former president of the Baltimore and Ohio Railroad administered by a corporation known as the "Oscar G. Murray Railroad Employees Benefit Fund" for the relief and assistance of needy widows and orphans of employees of the Baltimore and Ohio Railroad who have died in the service of that company, preference being given to the widows and orphans of employees living in Baltimore City. The fund upon the expiration of certain annuities will have capital assets of $700,000. The investigation

the changing conditions of industry had materially reduced the chance of each journeyman becoming himself a master, ephemeral combinations passed into permanent trade societies, recruited for many years from trades carried on exclusively by hand workers.

The modern labor organization rests on the definite separation between the functions of the managers, the capitalist, and the workmen, or, in other words, between the direction of industrial operations and their execution in detail; between the brain worker and the property owner on the one hand and the manual workers on the other.

The trade-unions describe themselves as "a continuous association of wage earners for the purpose of maintaining or improving the condition of their employment." There is no evidence of the existence prior to 1700 of continuous associations of wage earners. The pioneers of the trade-union movement were the extensive combinations of the west of England woolen workers and the midland framework knitters. Throughout the eighteenth century they had a meager and uncertain existence, but the introduction of the factory system was accompanied by a rise over a period of 50 years in trade combinations, and early in the nineteenth century they had become very highly developed and firmly established in many trades. Their struggle for existence went on until 1825, and they languished through a long period of commercial depression until, with the business revival of 1843, they began to acquire a financial strength and a permanence of membership before unknown, through a combination of the functions of a trade protective society with those of a permanent insurance company and a transfer of the leadership from the casual enthusiast and agitator to a class of permanent, salaried officers. This "new model" had become generally adopted by 1860. Then came a new idea; the use of the combined trade-union organization for legislative agitation; and now, since 1889, the whole trade-union world has become permeated with collective ideas and is drifting toward socialism, and in some countries is engulfed in Soviet socialism.

It would seem impossible, by a statistical survey, to give an adequate idea of the trade-union organization. It numbers in the United States apparently about four per cent of the population and about 10 per cent of those engaged in gainful occupations. What gives it great significance is the massing of trade-unionists in such a way as to form a powerful element of the industrial world in certain industries and districts where the population is comparatively dense and where industry is conducted on a large scale. Perhaps three-fourths of its members are engaged in steam and electric transportation, mining, building and the machinists' trades. In certain districts and in certain industries membership embraces practically all the manual laborers. On the other hand, there are many occupations in which trade unionism is non-existent. In its growth, speaking generally, the strong have become stronger, while those that were weak are now even weaker than they were.

The trade-union has, throughout its whole history, tended to the amalgamation of local trade clubs into national unions, with centralized funds and centralized administration. This centralization of administration, involving the adoption of a national trade policy, and above all the constant leveling up of the lower-paid districts to the higher standards set in more advantageous centers, accompanied far too often by the character and amount of the work to be done being consistently set by the least skillful and competent, requires the development of a salaried staff, selected for special capacity, devoting their whole attention to the positions and technical details of the particular section of the industry that they represent, and having authority to act for the whole of that section throughout the nation. The effect of this has been one of the most potent influences in disturbing the equilibrium between rural and urban industry and population.

Among the active members of the trade-union ranks, there are the secretaries and presidents of local unions, branches and district committees of national societies, and of trade councils. These men number 20,000 or more; they form the skeleton of the trade-union world and constitute

the vital element of its politics. The government of the unions actually rests exclusively in the hands of the salaried officers of the great associations, numbering at the present time less than 1000, and these in turn are dominated by an inner circle of a few score men. Looking at this development and at the present situation, the question has been raised as to whether we now have a condition of "organized labor" or a condition of "labor professionally organized"; whether this great mass is energized from below and consciously seeks its own betterment, or whether it responds to pressure from above, exploiting and being exploited for the benefit of its rulers.

Notwithstanding their almost infinite variety of technical detail, the activities of trade-unionism are manifested through two economic devices—restriction of numbers and the common rule. To the former type belong the entrance to a trade, the right to a trade, continuity of employment, and new processes and machinery. The latter type includes the more modern rules directly fixing a standard rate, a normal day, limitation of output, and conditions of sanitation and safety.

The early efforts of the unions looked to the creation of an artificial scarcity of labor. They sought to restrict the entrance to a trade by the establishment of a long period of apprenticeship; to restrict the right to an apprenticeship to a patrimony to be conferred by the father upon his sons, and to restrict the number of apprentices to one for four or five journeymen; to enforce a limitation of boy labor and of handy-men, and to limit the progression of the latter within the trade; and to exclude women altogether. Some, by imposing large initiation fees or other penalties, tried to keep out many possible aspirants. Each union sought to secure for its members the whole of the work which it considered belonged to it according to usage and custom, and to secure for them continuity of employment, while all considered improvements which tended to lessen the demand for human labor as the deadliest curse which could possibly fall on the heads of the workers.

The later efforts of the unions enlarge this programme by

further emphasis upon the creation of an artificial demand for labor. They seek payment according to a standard rate uniform in its application, covering payment by the piece and payment by time, with a guaranteed minimum wage, a uniform maximum working time for all members of the craft as fixing a definite unit of measure, and a constant reduction of working hours as a means of absorbing surplus labor,[1] safe, healthy and comfortable conditions of work, compensation for accidents, whether avoidable or unavoidable, and permanent support when out of work, or invalided, and during old age.

If now, we ask how this extensive body, with this comprehensive programme, is held together, we are able to identify the following forces:

1. The trade-union organization, is, the Webbs say, as a unit, a lodge with a ritual largely based upon that of the Odd Fellows, and supplies to men who have a common experience and who are brought frequently into personal contact much social attraction, and, to the active and ambitious, opportunities for personal prominence and the exercise of individual power.

2. The cohesion, the permanence of membership, the continuity of existence, rest upon the method of mutual insurance. But many investigators are of the opinion that by far the most potent force is the pressure brought by the dominant spirits upon the isolated and unprotected individual. Whether this takes the form of the temporary abstraction of the tools of a workman, interference with his work, personal annoyance, the abuse or ostracism of his

[1] The following is an extract from a report by the Committee on Shorter Workday of the American Federation of Labor, unanimously approved by the federation at its Fortieth Annual Convention held in Montreal, P. Q., on June 12, 1920:

> "There is no doubt but that in the near future many organizations will determine that *in order to take care of all their members* gaining a livelihood by employment at their trade, it will be necessary to inaugurate a six-hour day.
>
> "Your committee, therefore, recommends further that the Executive Council lend its assistance to the fullest degree to any organization seeking to establish a shorter workday *that will provide for the employment of all its members.*"

family, or other of the manifold ways in which this pressure is exerted, they point out that all are infringements of personal liberty and an assertion of the right and the intention to make trade-unionism compulsory; that in their ultimate development, these coercive measures create the closed shop, with its concomitant devices of membership cards and buttons, the "check-off" system and the union label.

3. By their opposition to home work, small employers, separate arrangements with particular employers, profit-sharing, pension funds, employees' benefit societies, and similar efforts to bring about mutuality of interest, trade unions appear consistently to work to bring about a horizontal cleavage of society. Any one enmeshed in a particular stratum would then find escape impossible; all the worst features of the caste system would be invoked, and the chief merit of democracy, which is the open passage from the lowest to the highest position in the community, would be defeated.

If, further, we look to ascertain the methods by which trade-unionism seeks to enforce its claims upon the employer, we find from the beginning of the eighteenth century down to the present day the continuous use of the Method of Legal Enactment. Only intermittently during the eighteenth century, and not openly and avowedly until 1824, could they place reliance on the Method of Collective Bargaining.

The Method of Legal Enactment results in the labor unions maintaining at every session of the state legislatures and of congress lobbies working in their interest. The control of the law is invoked for sanitation and safety, for limitation of the hours of labor, for restriction of labor of women and children and of the age at which youth may be employed, for the creation of parasitic labor and in many other ways. It has destroyed many efforts that might have been developed to ameliorate conditions. Such legislation has made the struggle for existence harder for the farmer and the small manufacturer in the country town, and if in the short view it has seemed to help those in whose interest it was passed, it has often been hurtful to the rest of the community.

The Method of Collective Bargaining, which is the form in which claims are most often presented, has never commended itself to the employer, and where the two parties are more nearly equal in strength, has, after trial, generally been abandoned. The chief difficulties seem to be the lack of responsibility on the part of the labor unions in observing the bargain when made, and the disposition of the unions to assert under their rules the authority to control the business, and the details of its operation.

As to the strike, with its concomitants, the boycott and other militant methods, upon which the strength of the union appears ultimately to depend, it constitutes industrial war and has all the defects of war. It is pointed out that the effectiveness of the strike would appear to depend upon the disorder, violence and crime which have distinguished it in all countries, at all times, and among all unions; that it always reveals the use of means that could only be resorted to by those familiar with the technic of the trade, definitely identifying its directing source; that the unions have never undertaken to discipline or expel members known to have resorted to violence, nor have they in any way assisted the authorities in preventing such action or in punishing the offender; and that their uniform denunciation of the courts, particularly in connection with the use of the process of injunction, the navy, the army and the militia, the sheriff with his *posse comitatus*, the police, and even the Boy Scouts, evidences a systematic effort to weaken in their interests the resources that civilization has developed for the preservation of order.

Finally, if we seek for the grounds upon which the trade unions base their claim to an existence, there would appear to be two contentions not necessarily related:

1. That the actual producers do not obtain their share of the wealth they create; and
2. That the laborer is entitled to a living wage.

No one thing, perhaps, so embitters as a sense of injustice, and I am satisfied that much of the resentment of the work-

man is due to his belief in the assurances that are so frequently urged upon him that he is not getting his fair share of the joint product. Very often this is stated in the extreme form of "labor produces it all and shall have all." It is, then, highly important that the facts be determined and widely diffused.

The problem of the "relative contribution" is a much more important one at the present time than the problem of the "distribution of the product." It must be evident, upon a review of the development of industry, that the contributing efforts which the laborer is called upon to make steadily and rapidly decline, while the efforts contributed by management and capital even more steadily and rapidly increase, and that the distributive share of the joint product enjoyed by the laborer steadily and rapidly increases, while that of management and capital correspondingly decreases.

Two differing views as to the "standard of living" are voiced by Sidney and Beatrice Webb and by John Mitchell. The Webbs say:

> A serious difficulty is our lack of precise knowledge as to what are the conditions of healthy life and industrial efficiency. There are practically no scientific data from which we can compute the needs of particular occupations. The customary standards of life differ from class to class to such an extent as to bear no discoverable relation to the waste and repair involved in the respective social functions of the various grades. Even if we could come to some conclusion as to the "normal ration" required to keep each trade in health, we would still be unable to decide how much must be added in each case to compensate for irregularity of employment. If special wages were fixed to meet the special needs of particular trades, neither the employer nor the community would have any guarantee that the extra sum allowed would be spent in extra nourishment, proper recreation, or insurance against periods of unemployment.

John Mitchell, President of the United Mine Workers of America, in 1902, defining the American standard of living and the annual income needed to maintain it, says:

> In cities of from 5000 to 100,000 inhabitants, the American standard of living should mean, to the ordinary unskilled workman

with an average family, a comfortable house of at least six rooms. It should mean a bathroom, good sanitary plumbing, a parlor, dining room, kitchen, and sufficient sleeping room that decency may be preserved and a reasonable degree of comfort maintained. The American standard of living should mean, to the unskilled workman, carpets, pictures, books and furniture with which to make home bright, comfortable and attractive for himself and his family, an ample supply of clothing suitable for winter and summer, and above all a sufficient quantity of good, wholesome, nourishing food at all times of the year. The American standard of living, moreover, should mean to the unskilled workman that his children be kept in school until they have attained the age of 16 at least, and that he be enabled to lay by sufficient to maintain himself and his family in times of illness, or at the close of his industrial life, when age and weakness render further work impossible, and to make provision for his family against his premature death from accident or otherwise.

This, or something like this, is the American standard of living, as it exists in the ideals of the unskilled workingmen. . . .

What wages, therefore, are necessary to maintain this American standard? This question was put to me by the attorneys for the coal companies during the sessions of the Anthracite Coal Strike Commission, and at that time I stated that the very least upon which an unskilled workman could maintain a desirable standard of living, was $600 a year. . . . Less than this would, in my judgment, be insufficient to give to the workingman those necessaries and comforts and those small luxuries which are now considered essential.

Allowing for an increase of 115 per cent in the cost of living since 1902, which certainly is liberal in view of the mine workers' estimate of 110 per cent increase since 1906 (Exhibit No. 20, page 4, Anthracite Arbitration, 1920), John Mitchell's $600 of 1902 becomes $1290 in May, 1920.

But the test of the so-called "living wage" cannot be applied. For one thing, no agreement could be reached or long maintained as to the standard of living, and, for another, the contention will no longer be stressed when we experience a marked decline in prices. But to make the contention is to "put the cart before the horse." We are engaged in a ceaseless struggle with nature for our very existence. Unless we work neither shall we eat. It is not, then, the case that unless we can live as we choose we will not work but rather

that as we choose to work so may we live. Every one recognizes the importance of a high standard of living, not only to the individual and his family, to the community and state, but to the future of society and the race; but what it is important also to recognize is the fact that this is an effect, not a cause, a thing for which a price has to be paid, a thing bought with steadfast application, earnest effort, self-restraint and self-sacrifice. A high standard of living is a consequence of high productivity and can only be maintained in a growing community by constantly increasing productivity. Wages and hours depend not upon the cost of living, but upon what other people will give you in exchange for what you make yourself. For good or ill it is not alone upon his physical exertion but upon his character and conduct that man's condition depends. Upon the exercise of self-reliance and forethought, upon a recognition of the need for and the practice of honest, strenuous, and persevering effort, the future is conditioned.

With regard to the proper limits to be set to the duration of toil, while all would welcome a maximum working day consistent with the healthy existence, home life and citizenship of the average workmen, yet in the final analysis the whole destiny of man must rest upon the use made of his leisure time. It is a sinister experience that a holiday will fill the hospitals with victims whom months of toil have left unscathed.

The assertion that "the right to organize is denied" is a man of straw, set up to be knocked down. There is no such denial. What is distrusted in trade-unionism is not its object ("a continuous association of wage earners for the purpose of maintaining and improving the condition of their employment") nor even its devices ("restriction of numbers and the common rule"), economically unsound as many of their implications are, but rather its structure and its methods; the self-perpetuating governing oligarchy, the creation of parasitic labor, the lying idle of costly and perishable machinery in plant, the dislocation of business enterprises, the diversion of orders to other communities and other

countries, and the absorption in angry quarrels of intellects which would otherwise be devoted to the further development of industry; above all, the reduction to poverty and semi-starvation of thousands of workmen. The right to work is the right of every man, and this right, if what Saint Paul said is true ("But if any provide not for his own and especially for those of his own house, he hath denied the faith and is worse than an infidel"), is the first, the most sacred, and the most inalienable of all. If, as is said, trade-unionism is to rest upon collective bargaining, and if this implies in its fullest development compulsory membership, then it menaces the fundamental rights of citizenship. The justification put forward for this compulsion is that it is for the good of the compelled. It is not reassuring to recall that this was the basis for the religious persecutions of the past, and it is pointed out that the trade-unions often display the same intolerance, the same extreme claims for superior rights, and the same ferocious cruelty that characterized the persecuting sects.

No society or state may regard with unconcern the growth within its midst of "secret societies." The "Order of the Illuminati," and the "Jacobin Clubs" of the French Revolution and of the "Terror" have their logical successor in the recent English "Council of Action" seeking to overthrow government and grasp the reins of power. Only the entire citizenry can be loyal to a form of government. A particular class will attach itself to the government only if the government confers benefits upon it. It is to the interest of every citizen that we should have, as our fathers contemplated, a commonwealth founded upon industry and frugality, economy and recognition of the rights of those who save and invest, wait and lead, take risks and responsibilities, as well as upon those who obey and work with their hands.

We have difficulty not only in adapting ourselves to our environment, but in learning to live with each other. It is important to keep in mind that human nature is little moved by reason and the intellectual aspect of the mind; it is not by these that the sound relations of men are determined,

but rather, by feeling, emotion, denial and intuition, by deeply seated preferences and prejudices. No study of social phenomenon is worth while that does not give due weight to them all.

One of the worst features of labor organizations is that they have pursued a course that has weakened the sentiments of loyalty and as steadily promoted sentiments of antagonism and which now bid fair, as least in the case of some, to bring them as a body to an attitude of sedition, and as individuals to acts of treason. That certainly has been their lamentable course in other countries.

While the situation is constantly changing, the following decisions of the Supreme Court of Kentucky state the legal position:

A labor union, as such, engages in no business enterprise. It has not the power, and does not undertake, to supply employers with workmen. It does not, and cannot, bind its members to a service for a definite, or any period of time, or even to accept the wages and regulations which it might have induced an employer to adopt in the conduct of his business. Its function is to induce employers to establish usages in respect to wages and working conditions which are fair, reasonable and humane, leaving to its members each to determine for himself whether or not and for what length of time he will contract with reference to such usages. . . . It (the trade agreement) is just what it on its face purports to be and nothing more. It is merely a memorandum of the rates of pay and regulations governing, for the period designated, enginemen employed on the Chattanooga Division of the company's railway. Having been signed by the appellee, it is evidence of its intentions, in the conduct of its business with enginemen in said division to be governed by the wages and rules, and for the time therein stipulated, enginemen in, or entering its service during the time limit, contract with reference to it. There is on its face no consideration for its execution. It is, therefore, not a contract. It is not an offer, for none of its terms can be construed as a proposal. It comes squarely within the definition of usage as defined in Byrd *v.* Beall, 150 Ala. 122, 43 So. 749. There the court in defining "usage" refers to an established method of dealing, adopted in a particular place, or by those engaged in a particular vocation or trade which acquires legal force because people make contracts with reference to it. The so-called "contract" which a trade-union makes with an employer or an employer's association is merely a "gentlemen's agreement,"

a mutual understanding, not enforceable against anybody. It is an understanding that, when the real labor contract is made between the individual employer and the individual employee it shall be made according to the terms previously agreed upon. But there is no legal penalty if the individual contract is made differently. To enforce a collective contract would be to deny the individual's liberty to make his own contract. (Supreme Court of Kentucky.)

271. Open Shop.—It is difficult to understand why, under this constant and great pressure, the employers were not early driven into combination for purposes of resistance to aggression. In 1902 and 1903 there were formed in numerous cities organizations called "Citizens' Alliances," of which Los Angeles has, perhaps, the most conspicuous present example, and of these there are many variations, such as the "Open Shop Councils," the growth of which has of late been very rapid in the southwest. A little later there came into existence for the first time continuous associations of employers.

If both parties organize to control wages and conditions of employment, as they become more nearly equal in strength, we shall enter upon a new phase. Practically every capitalist and enterpriser has had the experience of the laborer, knows thoroughly this phase of life in at least one branch of endeavor, and looks forward to the probability of his great grandchildren having to make their start from the same level. Practically no laborer has had the experience of the capitalist or of the enterpriser, and he usually conceives a radically wrong picture of their activities, environment and motives. It is to associations of employers, therefore, not to labor organizations, that we may look with hope for practical solutions of the questions involved.

The present position may be indicated by the declaration of the employers' group at the President's First Industrial Conference in October, 1919, the declaration of the labor group at the same conference, the platform adopted by the United States Chamber of Commerce in July, 1920, and the 16 principles set forth by the United States Railroad Labor Board in its Decision No. 119, dated April 14, 1921, all of

which follow. In considering these several declarations the technical and special significance placed upon some of the words used must be kept in mind.

STATEMENT OF PRINCIPLES WHICH SHOULD GOVERN EMPLOYMENT RELATIONS, PRESENTED AT PRESIDENT'S FIRST INDUSTRIAL CONFERENCE BY EMPLOYER GROUP, OCTOBER, 1919.

Sound industrial development must have as its foundation productive efficiency, and high productive efficiency requires not only energy, loyalty, and intelligence on the part of management and men, but sincere coöperation in the employment relation, based upon mutual confidence and sympathy.

This is true of all producing industries, large and small, of the farming industry as well as the manufacturing. While there are differences between the different branches of industry which call for special application of the underlying principles, these principles are the same in all.

Without efficiency in production, that is to say, without a large product economically produced, there will be no fund for the payment of adequate compensation for labor, management and capital, and high cost of living will inevitably continue. Moreover, without such efficiency, it will be impossible for American industry successfully to compete in foreign markets or with foreign competition in this country. The larger and more effective the production, the greater will be the return to all engaged in the industry and the lower the cost of living. The requisite efficiency in production cannot be secured unless there is effective coöperation between employer and employee such as is only possible where, with a full understanding of each other's point of view, management and men meet upon a common ground of principle and in a spirit of coöperation based upon good understanding and a recognition of what is fair and right between the two. Then only can there be that harmony which will insure the prosperity of those engaged in industry and of all the people.

With full recognition of the vital importance of these conditions, and with due realization of the great responsibility resting upon management to secure their practical application in industrial affairs, we submit the following principles which we regard as fundamentally sound in the interest of industry, of those employed or concerned in industry, and of the people as a whole.

1. *Production.*—The industrial organization of a productive agency is an association of management, capital, and labor voluntarily established for economic production through coöperative

effort. It is the function of management to coördinate and direct capital and labor for the joint benefit of all parties concerned and in the interest of the consumer and of the community. No employment relation can be satisfactory or fulfill its functions for the common good which does not encourage and require management and men to recognize a joint as well as an individual obligation to improve and increase the quantity and quality of production to as great an extent as possible, consistent with the health and well-being of the workers.

There should be no intentional restriction of productive effort or output by either the employer or the employee to create an artificial scarcity of the product or of labor in order to increase prices or wages; nor should there be any waste of the productive capacity of industry through the employment of unnecessary labor or inefficient management.

It is the duty of management on the farms and in industry and commerce, as far as possible, to procure the capital necessary for the increased production that is required, and of both management and labor to coöperate to promote the use of capital in the most efficient fashion.

2. *The Establishment as a Productive Unit.*—Recognizing the coöperative relationship between management and men essential to productive efficiency as a prerequisite for national and individual well-being, the establishment rather than the industry as a whole or any branch of it should, as far as practicable, be considered as the unit of production and of mutual interest on the part of employer and employee. Here, by experimentation and adaptation, should be worked out and set up satisfactory means for coöperative relations in the operation of the establishment, with due regard to local factors.

Each establishment should develop contact and full opportunity for interchange of view between management and men, through individual or collective dealing, or a combination of both, or by some other effective method, always predicated on both sides on honesty of purpose, fairness of attitude, and due recognition of the joint interest and obligation in the common enterprise in which they are engaged.

Mere machinery is not enough for this purpose. There must also be sympathy and good will, with earnest intent that, whatever the means employed, they must be effective.

3. *Conditions of Work.*—It is the duty of the management to make certain that the conditions under which work is carried on are as safe and as satisfactory to the workers as the nature of the business reasonably permits. Every effort should be made to maintain steady employment of the workers both on their account

and to increase efficiency. Each establishment should study carefully the causes of unemployment, and individually and in coöperation with other establishments in the same and other industries should endeavor to determine and to maintain conditions and business methods which will result in the greatest possible stability in the employment relation.

4. *Wages.*—While the law of supply and demand must inevitably play a large part in determining the wages in any industry or in any establishment at any particular time, other conditions must be taken into account, such as the efficiency of the worker and the wage standard of the industry in the locality. The wage should be so adjusted as to promote the maximum incentive consistent with health and well-being and the full exercise of individual skill and effort. Moreover, the business in each establishment and generally in industry should be so conducted that the worker should receive a wage sufficient to maintain him and his family at a standard of living that should be satisfactory to a right-minded man in view of the prevailing cost of living, which should fairly recognize the quantity and quality of his productive effort and the value and length of his service, and reflect a participation on his part in the prosperity of the enterprise to which he is devoting his energy.

Many plans are now under consideration for adding to the fixed wage of the worker, such, for example, as bonus payments, profit-sharing, and stock ownership. All such plans should be carefully studied in each establishment. It may well be that in many instances the employer and the employee could work out an arrangement of such a character to their mutual advantage.

In order that the worker may in his own and the general interest develop his full earning capacity and command his maximum wage, it should be a primary concern of management to assist him to secure employment suited to his abilities, to furnish him incentive and opportunity for improvement, to provide proper safeguards for his health and safety, and to aid him to increase the value of his productive effort.

Where women are doing work equal with that of men under the same conditions, they should receive the same rates of pay as men and should be accorded the same opportunities for training and advancement.

5. *Hours of Work.*—Hours of work schedules should be fixed at the point consistent with the health of the worker and his right to an adequate period of leisure for rest, recreation, home-life, and self-development. To the extent that the work schedule is shortened beyond this point, the worker as well as the community must inevitably pay in the form of a reduced standard of living.

The standard of the work schedule should be the week, varying

as the peculiar requirements of individual industries may demand. Overtime work should, as far as possible, be avoided, and one day of rest in seven should be provided.

6. *Settlement of Disputes.*—Each establishment should provide adequate means for the discussion of all questions and the just and prompt settlement of all disputes that arise between management and men in the course of industrial operation, but there should be no improper limitation or impairment of the exercise by management of its essential function of judgment and direction.

7. *Right to Associate.*—All men have the right to associate voluntarily for the accomplishment of lawful purposes by lawful means. The association of men, whether of employers, employees, or others, for collective action or dealing confers no authority and involves no right of compulsion over those who do not desire to act or deal with them as an association. The arbitrary use of such collective power to coerce or control others without their consent is an infringement of personal liberty and a menace to the institutions of a free people.

8. *Responsibility of Associations.*—The public safety requires that there shall be no exercise of power without corresponding responsibility. Every association, whether of employers or employees, must be equally subject to public authority and legally answerable for its own conduct or that of its agents.

9. *Freedom of Contract.*—With the right to associate recognized, the fundamental principle of individual freedom demands that every person must be free to engage in any lawful occupation or enter into any lawful contract as an employer or an employee, and be secure in the continuity and rewards of his effort. The freedom of a man to work is as sacred as is his freedom to religious worship and must not be subject to restriction or menace.

The only qualification to which such liberty of contract is subject lies in the power of the state, within limits imposed by the constitution, to regulate in the public interest, for example, for the promotion of health, safety, and morals.

10. *The Open Shop.*—The principles of individual liberty and freedom of contract, upon which our institutions are fundamentally based, require that there should be no interference with the "open shop," that is, the shop in which membership or non-membership in any association is not made a condition of employment. While fair argument and persuasion are permissible, coercive methods aimed at turning the "open shop" into a "closed union" or "closed non-union shop" should not be tolerated.

There should be no denial of the right of an employer and his workers voluntarily to agree that their relation shall be that of the "closed union shop" or of the "closed non-union shop." But

the right of the employer and his men to continue their relations on the principle of the "open shop" should not be denied or questioned. No employer should be required to deal with men or groups of men who are not his employees or chosen by and from among them.

Under the organization of the "open shop" there is not the same opportunity for outside interference on the part of other interests to prevent close and harmonious relations between employer and employee. Their efforts to continue to secure such harmonious relationship are not complicated to the same extent by intervention of an outside interest which may have aspirations and plans of its own to promote, which are not necessarily consistent with good relations in the shop.

11. *The Right to Strike or Lockout.*—In the statement of the principle that should govern as to the right to strike or lockout, a sharp distinction should be drawn between the employment relations in the field (*a*) of the private industry, (*b*) of the public utility service, and (*c*) of government employment, federal, state, or municipal. In all three there are common rights and obligations, but in so far as the right to strike or lockout is concerned, the nature of the government service and public utility operations requires that they should be considered from a somewhat different point of view than private industry.

In private industry the strike or the lockout is to be deplored; but the right to strike or lockout should not be denied as an ultimate resort after all possible means of adjustment have been exhausted. Both employers and employees should recognize the seriousness of such action and should be held to a high responsibility for the same.

The statement that the right to strike or lockout should not be denied does not cover the matter of the sympathetic strike or lockout, where for mere purposes of coercion there is a combination deliberately inflicting injury upon parties against whom the assailants have no grievance, for the purpose of accomplishing an ulterior result. The sympathetic strike is indefensible, anti-social, and immoral. The same may be said of the black list, the boycott, and also of the sympathetic lockout.

In public utility service the public interest and welfare must be the paramount and controlling consideration. Modern social life demands the uninterrupted and unimpaired operation of such service, upon which individuals and communities are as dependent as is human life on the uninterrupted circulation of the blood. The state should, therefore, impose such regulations as will assure continuous operation, at the same time providing adequate means for the prompt hearing and adjustment of complaints and disputes.

In government employment the orderly and continuous adminis-

tration of governmental activities is imperative. A strike of government employees is an attempt to prevent the operation of government until the demands of such employees are granted, and cannot be tolerated. No public servant can obey two masters; he cannot divide his allegiance between the government which he serves and a private organization which, under any circumstances, might obligate him to suspend his duties or agrees to assist him morally or financially if he does. Social self-defense demands that no combination to prevent the operation of government be permitted. The right of government employees to be heard and to secure just redress should be amply safeguarded.

12. *Training.*—Practical plans should be inaugurated in industry and outside of it for the training and upgrading of industrial workers, their proper placement in industry, the adoption and adaptation of apprenticeship systems, the extension of vocational education, and such other adjustments of our educational system to the needs of industry as will prepare the worker for more effective and profitable service to society and to himself.

The foregoing is limited to a statement of principles. Only casual reference has been made to methods by which such principles may be carried into effect. The problems are so serious and difficult that such methods must be worked out by the individual establishments in conjunction with their employees and by industry as a whole.

PROPOSITIONS PRESENTED AT PRESIDENT'S FIRST INDUSTRIAL CONFERENCE BY LABOR GROUP, OCTOBER, 1919.

This conference of representatives of the public, of the employers, and business men, and of labor, called by the President of the United States, hereby declares in favor of the following:

1. The right of wage earners to organize in trade and labor unions for the protection and promotion of their rights, interests, and welfare.

2. The right of wage earners to bargain collectively through trade and labor unions with employers regarding wages, hours of labor, and relations and conditions of employment.

3. The right of wage earners to be represented by representatives of their own choosing in negotiations and adjustments with employers in respect to wages, hours of labor, and relations and conditions of employment.

4. The right of freedom of speech, of the press, and of assemblage, all being responsible for their utterances and actions.

5. The right of employers to organize into associations or groups to bargain collectively through their chosen representatives in respect

to wages, hours of labor, and relations and conditions of employment.

6. The hours of labor should not exceed eight hours per day. One day of rest in each week should be observed, preferably Sunday. Half holiday on Saturday should be encouraged.

Overtime beyond the established hours of labor should be discouraged, but when absolutely necessary should be paid for at a rate not less than time and one-half.

7. The right of all wage earners, skilled and unskilled, to a living wage is hereby declared, which minimum wage shall insure the workers and their families to live in health and comfort in accord with the concepts and standards of American life.

8. Women should receive the same pay as men for equal work performed. Women workers should not be permitted to perform tasks disproportionate to their physical strength or which tend to impair their potential motherhood and prevent the continuation of a nation of strong, healthy, sturdy and intelligent men and women.

9. The services of children less than 16 years of age for private gain should be prohibited.

10. To secure a greater share of consideration and coöperation to the workers in all matters affecting the industry in which they are engaged, to secure and assure continuously improved industrial relations between employers and workers, and to safeguard the rights and principles hereinbefore declared, as well as to advance conditions generally, a method should be provided for the systematic review of industrial relations and conditions by those directly concerned in each industry.

To this end there should be established by agreement between the organized workers and associated employers in each industry a national conference board consisting of an equal number of representatives of employers and workers, having due regard to the various sections of the industry and the various classes of workmen engaged, to have for its object the consideration of all subjects affecting the progress and well-being of the trade, to promote efficiency of production from the viewpoint of those engaged in the industry, and to protect life and limb, as well as safeguard and promote the rights of all concerned within the industry.

With a further view of providing means for carrying out this policy, the federal government, through its Department of Labor, should encourage and promote the formation of national conference boards in the several industries where they do not already exist. Still further to encourage the establishment of these national conference boards in each industry these conference boards should be urged, whenever required, to meet jointly to consider any proposed legislation affecting industries, in order that employers and workers

may voluntaily adopt and establish such conditions as are needful, and may also counsel and advise with the government in all industrial matters wherever needful legislation is required.

The federal government should also undertake to extend the functions of the Department of Labor to ascertain and provide adequate information and advice to the several national conference boards on all matters affecting the life, health, and general welfare of the wage-earners within such industries.

11. The flow of immigration should at no time exceed the nation's ability to assimilate and Americanize the immigrants coming to our shores, and at no time shall immigration be permitted when there exists an abnormal condition of unemployment.

By reason of existing conditions we urge that all immigration into the United States be prohibited at least until two years after peace shall have been declared.

PRINCIPLES UNDERLYING THE EMPLOYMENT RELATIONS, ADOPTED BY THE CHAMBER OF COMMERCE OF THE UNITED STATES, JUNE, 1920.

I. *The Employment Relation*

Every person possesses the right to engage in any lawful business or occupation and to enter, individually or collectively, into any lawful contract of employment, either as employer or employee. These rights are subject to limitation only through a valid exercise of public authority.

II. *The Open Shop*

The right of open-shop operation, that is, the right of employer and employee to enter into and determine the conditions of employment relations with each other, is an essential part of the individual right of contract possessed by each of the parties.

III. *Right of Association*

All men possess the equal right to associate voluntarily for the accomplishment of lawful purposes by lawful means. The association of men, whether of employers, employees or others, for collective action or dealing, confers no authority over, and must not deny any right of, those who do not desire to act or deal with them.

IV. *Responsibility of Combinations*

The public welfare, the protection of the individual, and sound employment relations require that associations or combinations of

employers or employees, or both, must equally be subject to the authority of the state and legally responsible to others for their conduct and that of their agents.

V. *Obligation to Secure Production*

To develop, with due regard for the health, safety and well-being of the individual, the required output of industry is the common social obligation of all engaged therein. The restriction of productive effort or of output by either employer or employee for the purpose of creating an artificial scarcity of the product or of labor is an injury to society.

VI. *Wages and Management*

The wage of labor must come out of the product of industry and must be earned and measured by its contribution thereto. In order that the worker, in his own and the general interest, may develop his full productive capacity, and may thereby earn at least a wage sufficient to sustain him upon a proper standard of living, it is the duty of management to coöperate with him to secure continuous employment suited to his abilities, to furnish incentive and opportunity for improvement, to provide proper safeguards for his health and safety and to encourage him in all practicable and reasonable ways to increase the value of his productive effort.

VII. *Hours of Labor*

The number of hours in the work day or week in which the maximum output, consistent with the health and well-being of the individual, can be maintained in a given industry should be ascertained by careful study and never should be exceeded except in case of emergency, and one day of rest in seven, or its equivalent, should be provided. The reduction in working hours below such economic limit, in order to secure greater leisure for the individual, should be made only with full understanding and acceptance of the fact that it involves a commensurate loss in the earning power of the workers, a limitation and a shortage of the output of the industry, and an increase in the cost of the product, with all the necessary effect of these things upon the interests of the community and the nation.

VIII. *Adjustment of Private Employment Relations*

Adequate means satisfactory both to the employer and his employees, and voluntarily agreed to by them, should be provided for the discussion and adjustment of employment relations and the just

and prompt settlement of all disputes that arise in the course of industrial operation.

IX. *Dealing Through Representatives*

When, in the establishment or adjustment of employment relations, the employer and his employees do not deal individually, but by mutual consent, such dealing is conducted by either party through representatives, it is proper for the other party to ask that these representatives shall not be chosen or controlled by, or in such dealing in any degree represent, any outside group or interest in the questions at issue.

X. *Community of Interest*

The greatest measure of reward and well-being for both employer and employee and the full social value of their service must be sought in the successful conduct and full development of the particular industrial establishment in which they are associated. Intelligent and practical coöperation based upon a mutual recognition of this community of interest constitutes the true basis of sound industrial relations.

XI. *Government Employment*

The state is sovereign and cannot tolerate a divided allegiance on the part of its servants. While the right of government employees—national, state or municipal—to be heard and to secure consideration and just treatment must be amply safeguarded, the community welfare demands that no combination to prevent or impair the operation of government or of any government function shall be permitted.

XII. *Public-Service Employment*

In public-service activities the public interest and well-being must be the paramount and controlling consideration. The power of regulation and protection exercised by the state over the corporation should properly extend to the employees in so far as may be necessary to assure the adequate, continuous and unimpaired operation of public-utility service.

Principles to Govern Relations Between Railroad Companies and their Employees, as Set Forth in U. S. Railroad Labor Board Decision No. 119.

1. An obligation rests upon management, upon each organization of employees, and upon each employee to render honest, efficient and economical service to the carrier serving the public.

2. The spirit of coöperation between management and employees being essential to efficient operation, both parties will so conduct themselves as to promote this spirit.

3. Management having the responsibility for safe, efficient and economical operation, the rules will not be subversive of necessary discipline.

4. The right of railway employees to organize for lawful objects shall not be denied, interfered with or obstructed.

5. The right of such lawful organization to act toward lawful objects through representatives of its own choice, whether employees of a particular carrier or otherwise, shall be agreed to by management.

6. No discrimination shall be practiced by management as between members and non-members of organizations or as between members of different organizations, nor shall members of organizations discriminate against non-members or use other methods than lawful persuasion to secure their membership. Espionage by carriers on the legitimate activities of labor organizations or by labor organizations on the legitimate activities of carriers should not be practiced.

7. The right of employees to be consulted prior to a decision of management adversely affecting their wages or working conditions shall be agreed to by management. This right of participation shall be deemed adequately complied with, if and when the representatives of a majority of the employees of each of the several classes directly affected shall have conferred with the management.

8. No employee should be disciplined without a fair hearing by a designated officer of the carrier. Suspension in proper cases pending a hearing, which shall be prompt, shall not be deemed a violation of this principle. At a reasonable time prior to the hearing he is entitled to be apprised of the precise charge against him. He shall have reasonable opportunity to secure the presence of necessary witnesses and shall have the right to be there represented by a counsel of his choosing. If the judgment shall be in his favor, he shall be compensated for the wage loss, if any, suffered by him.

9. Proper classification of employees and a reasonable definition of the work to be done by each class for which just and reasonable wages are to be paid is necessary, but shall not unduly impose uneconomical conditions upon the carriers.

10. Regularity of hours or days during which the employee is to serve or hold himself in readiness to serve is desirable.

11. The principle of seniority long applied to the railroad service is sound and should be adhered to. It should be so applied as not to cause undue impairment of the service.

12. The board approves the principle of the eight-hour day, but

believes it should be limited to work requiring practically continuous application during eight hours. For eight hours' pay eight hours' work should be performed by all railroad employees except engine and train service employees, regulated by the Adamson Act, who are paid generally on a mileage basis as well as on an hourly basis.

13. The health and safety of employees should be reasonably protected.

14. The carriers and the several crafts and classes of railroad employees have a substantial interest in the competency of apprentices or persons under training. Opportunity to learn any craft or occupation shall not be unduly restricted.

15. The majority of any craft or class of employees shall have the right to determine what organization shall represent members of such craft or class. Such organization shall have the right to make an agreement which shall apply to all employees in such craft or class. No such agreement shall infringe, however, upon the right of employees not members of the organization representing the majority to present grievances either in person or by representatives of their own choice.

16. Employees called or required to report for work, and reporting but not used, should be paid reasonable compensation therefor.

272. Parasitic Labor.—This "making jobs" which organized labor has sought to effect in numerous ways has as its motive a general elimination of unemployment, with the general purpose of furnishing work for the idle and the selfish purpose of avoiding competition for work by the idle. It is, however, a fallacy and it is difficult to see how this fallacy can be so long and so generally accepted by so intelligent a body as the railroad workers. The employment of labor is dependent in the last analysis upon efficient production. To fancy that more work is provided by employing more men to do the same work is like fancying that the man who has four quarters has more money than the man who has a dollar bill. Reduction of output and another popular device, reduction of hours, as means of making more jobs and reducing unemployment, have been universally condemned by competent writers. John Rea says:

It cannot make any serious impression on the unemployed. Yet that is the very benefit which seems to be most ardently and confidently expected. Underneath this form of the fallacy . . . there

lives the idea that there exists some force able to keep up the normal consumption of society after its normal production is allowed to fall. But the only thing able to keep up the normal consumption of society, and the only thing able to keep up the normal consumption of individuals, is their means of paying for it, their means of employing labor to supply it, and, when their means fail, society like individuals must simply go without and cannot employ more labor.

In discussing the relation of reductions in work hours to unemployment following the Armistice, Mr. Lloyd George said:

There is a theory that one way of providing employment is by reducing the hours of labor, and that there will be enough work to go round at the same wages. Reduce the hours of labor to what is legitimate and what is fair and possible, but to reduce them merely in order to create employment for exactly the same wages is the one way to make unemployment over the whole country. I should have thought that stood to reason; it is really so elementary. It increases the cost of a particular commodity which a trade is producing, that commodity is an ingredient in something else; if you put up the price you diminish the purchasing capacity, and if you diminish the purchasing capacity you diminish employment.

And this may be said of every device to make jobs whether it be by diminishing output, preventing doubleheading, putting on a third brakeman, or others that are familiar. It has been suggested that "a more constructive policy would be to seek a better adjustment of industrial effort, so that every worker may be employed where he is most needed, seasonal fluctuations may be reduced as far as possible, and the means of distributing finished products more nearly perfected."

273. Strikes.—Perhaps the most serious interruption in the past to continuity of employment has come from strikes. Contrary to the statements carelessly made, few railroad officers have suffered in any way from strikes in which their companies have been concerned; many, indeed, have found here opportunities for advancement. There are men still living and some still in the service who were conspicuous in the strike on the Missouri Pacific Lines in 1886, others in the

strike on the Chicago, Burlington & Quincy R. R. in 1888, and still others in the general strike in 1894. During the score of years prior to 1914, the world appeared to have made great progress toward bringing about a lasting peace between the nations. In the beautiful building at The Hague, conferences reached agreement upon measures for arbitration and took measures to bind the nations to observe limitations in the interest of humanity should arbitration fail. Then broke out the most disastrous war in history. We have been exceedingly fortunate in that for 26 years we have enjoyed in the employment relations upon the railroads a measurable degree of peace. Arbitration broke down with the refusal of the "Big Four" Brotherhoods to submit their grievances to such settlement in August, 1916, and the abandonment of the principle by President Wilson. President Wilson urged upon congress the plea of public necessity and secured the passage of the "Adamson Act." A man of quick imagination and mercurial morals, he lacked that sense of perspective without which no man is safe in high places. Nor did he possess those long traditions of Americanism, without which no man can adequately represent the republic. Under the Transportation Act of February 28, 1920, the control of wages is now vested in the United States Railroad Labor Board.

A review of the more important strikes of former years may not be without a useful purpose. In considering them it is well to keep in mind the assertion of the United States Supreme Court in the Debs case that "it is a lesson which cannot be learned too soon or too thoroughly that under this government of and by the people the means of redress of all wrongs are through the courts and at the ballot-box, and that no wrong, real or fancied, carries with it any legal warrant to invite as a means of redress the coöperation of a mob, with its accompanying acts of violence."

274. *The Strike of 1877.*—The panic of 1873 was followed by five or six years of general stagnation in business. The fall in prices was accompanied by a reduction of wages in all lines of industry, including those of railroad employees, generally in amounts of ten per cent but in some cases of

20 per cent. When the feeling became general that the hard times were at an end the employees began to present demands for an increase in pay or the restoration of their former rates of wages, the general statement of grievances differing as the conditions differed on the several roads. The feeling of discontent and unrest grew in all classes of railway labor, but it was most prominent among the brakemen and firemen. The storm finally broke out on July 16, 1877, at Martinsburg, W. Va., on the Baltimore and Ohio Railroad, and rapidly spread to all parts of the country. Traffic was everywhere interrupted and great disorder prevailed, the most conspicuous and destructive violence being at Pittsburgh. The strike there had begun by freight crews refusing to go out with their trains. The reason for the strike given to the officers of the Pennsylvania Railroad was an order under which eastbound freight trains were doubled up on the Pittsburgh Division, two engines being attached to the combined train, which was then run with one conductor and one brakeman. The men gathered in large numbers at the East Liberty Stock Yards and compelled all freight trains to stop. On July 21, the strike culminated in violence and extensive destruction of railroad property. On the same day the first detachment of militia arrived from Philadelphia and undertook to clear the crossing near the roundhouse. They encountered violent resistance and upon being stoned finally fired on the mob, killing and wounding a number. The Pittsburgh militia were driven off and the Philadelphia militia sought shelter in the roundhouse. The mob destroyed the property of the company, setting fire to the station, roundhouse and freight depot, many cars loaded and empty and about 100 locomotives. The value of the property destroyed amounted to about $6,000,000, the greater part of which was finally recovered from Allegheny County through suits at law.

On the Pennsylvania Railroad the strike began on July 19; the culminating disorder and the arrival of the militia occurred on July 21; the strike was suppressed about July 27 and there was a general resumption of traffic on August 1.

On other lines in the country, the dates were not very different.

275. *Strike on the Missouri Pacific and Leased Lines, 1886 (Martin Irons Strike).*—On March 6, 1886, many of the employees of the Missouri Pacific and leased and operated lines, without previous notice or the presentation of any grievance, stopped work and refused to perform their duties, only stating to their several foremen that they had received orders from the Executive Officers of the Knights of Labor to stop work on account of the action of the Texas and Pacific Railway in discharging an employee named C. A. Hall.

At this time, the severance of the Texas and Pacific from the Missouri Pacific was complete, the United States Court having taken possession of the former for the benefit of its creditors; and at the time of the outbreak of the strike it was operated by the receivers, so the anomaly was presented of a strike without a redressable grievance.

The strikers immediately commenced interference with the movement of trains, uncoupling cars, disabling locomotives and other machinery, and by threats and intimidation prevented those who wished to work from doing so. On March 13, a petition was filed in the circuit court of the city of St. Louis asking for an injunction against interference with traffic. The injunction was issued and similar action was taken in the courts of all the states through which the lines of this railway system pass. The Missouri Pacific Railway adopted the policy of using all the machinery of the law to secure the protection of the authorities where traffic was interrupted. The acute period of the strike lasted 23 days.

On April 7, the company had in its employ, in all departments, 71 per cent of the number employed on March 6, when the strike began. This number was found to be entirely sufficient to operate the road, in view of the general falling off in business as a result of the strike. About 600 of the strikers returned to work and were accepted by the company. The total number of men who went out on strike was 3770.

Strike began	March 6.
Traffic generally resumed	March 29.
Strike formally ended	May 4.

276. *Strike on the Philadelphia and Reading Railway, 1887.*—It is rather difficult to understand the strike or series of strikes on the Reading road at this time. The newspaper reports of that date give very highly colored accounts of the strike and the amount of damage done. The Philadelphia and Reading Railway Company had a proprietary interest in a number of coal companies, and there is a tendency to confuse the strike of the miners with that of the railroad employees whereas they were separate and distinct.

During the year 1887, a general organization of all employees on this road as well as the miners of the proprietary companies was formed. Trainmen, engineers, firemen and miners all joined the Knights of Labor. In his letter to Lee, of February 2, 1890, T. V. Powderly said: "The men on the Reading Railway actually controlled the entire management and had everything their own way. . . . It was no uncommon thing for them to stop a down train on the main track and talk to an up train in order to settle some little matter."

The employees in charge of switching engines at Port Richmond refused to handle freight consigned to the Philadelphia Grain Elevator Company, giving as a reason that the Elevator Company did not employ Knights of Labor. Five engine crews were discharged for refusing to handle this freight, and the K. of L. leaders ordered a strike on account of their discharge. About 2500 men left the service, and their places were quickly filled. The K. of L. nominally maintained a strike for over a month, holding out in hopes of arbitration.

The four days represent the crucial period of the strike, according to the statement of President Corbin. The ties that bound the members to their organization proved to be very weak; a small number of yardmen would strike in one place, and by the time the yardmen had struck in another place the first strikers were ready to return to work. The strike of the miners occurred during the month of January, and was much more serious than the strike of the railway employees.

Strike began .... December 24.
Acute period ended...................... December 27.

277. *Strike on the Chicago, Burlington and Quincy Railroad, 1888.*—In the latter part of February, 1888, there was a strike of engineers and firemen of the C. B. & Q. R. R. While both the Brotherhood of Locomotive Engineers and the Brotherhood of Locomotive Firemen and Enginemen were involved, it was especially a strike of the B. of L. E. As the older and stronger of the two organizations, it took the initiative and the B. of L. F. & E. was forced to follow.

The main demands involved in this strike were a uniform rate of pay per mile run, regardless of other conditions, and the abandonment of the system of wages based upon classifying the men in accordance with length of service; a reversal of the policy of the order which had maintained a strike on the Pennsylvania Lines to secure such classification. This equalization of the rates of pay consisted in making the lower equal to the higher. While advocating the abolition of one system of classification, with singular inconsistency the strikers were willing to accept a classification based upon the grade of engine operated. The brotherhood made other demands of a very radical nature, namely, that all brotherhood men should be passed free, and that no examinations as to intelligence, understanding of rules, color blindness, etc., should be made unless agreed to by the brotherhood.

The brotherhood overestimated the strength of its position; they believed it would be impossible to fill their places. Many of the places were filled by Knights of Labor who had been employed on the Reading and had themselves been replaced by B. of L. E. members. The management was greatly embarrassed by the antagonism of rival lines and the attitude of Judge Gresham, of the U. S. Circuit Court, and his Receiver, General McNulta, of the Wabash, in dodging their responsibilities, both gentlemen having certain political aspirations.

The cost of this strike to both sides was heavy; the company not only lost a great deal of property by acts of the mob, but its traffic was seriously affected during nearly the whole of the year. Nearly all the strikers lost their positions; many saw the accumulations of years of hard labor disappear

in a moment, reducing their families to poverty, and a large number never again secured railway employment.

Strike began, about	February	25.
Sufficient new force secured	March	6.
Strike of C. B. & Q. switchmen	March	27.
Places of switchmen filled	March	31.

278. *Strike on the New York Central and Hudson River Railroad, 1890.*—At no time during this strike was there an entire cessation of traffic. Passenger traffic was partially interrupted for three days. The nominal duration was about six weeks, but no specific date for its termination can be given. It was not confined to any one class of employees but was dictated by the Knights of Labor, which enrolled members from all classes of labor. Preceding the strike, this organization had made rapid strides in membership along the lines of the New York Central. Previous to the principal strike, which occurred in August, there were several minor strikes of employees of the Central, but none was important and all were settled within a few hours.

There had been considerable correspondence between the Master Workman of District Assembly No. 246, Knights of Labor, W. G. Lee, and Grand Master Workman T. V. Powderly; Powderly very sensibly advised against a strike, but, as the correspondence shows, the members had been recruited very largely from the lower strata of employees and it was this class, according to Mr. Powderly, that caused the trouble. On August 8, between 4500 and 5000 men on the line between New York and Buffalo went out. The assigned reason was the discharge of 78 employees for cause. When pressed for a reason in each case, by the investigating committee, various reasons were assigned, but they were all very general. The Knights claimed the men were discharged for membership in the order. It would probably be correct to say that a majority were discharged, not for membership in the order, but for "pernicious activity" as agitators.

It would be difficult to establish any acute period during

this strike. The number of employees who lost their positions was from 3500 to 4000.

Strike began	August 6, 1890.
Strike broken at New York end........	August 12, 1890.
Strike broken at Albany end...........	August 16, 1890.
Traffic entirely resumed by............	August 25, 1890.

279. *Yard Strike at Buffalo, N. Y., 1892.*—The yard brakeman and conductors (members of the Switchmen's Union) in the employ of the Erie, the Lehigh Valley and the Buffalo Creek Railroads struck on the night of August 11, for increased pay. Their action was soon followed by incendiarism and violence which destroyed about $100,000 of railway property. The strikers disclaimed complicity with these acts, but inside information indicated that violence had been discussed at a meeting of the S. M. B. & A. A. Before the public had any knowledge of the merits of the strike, fires had been started among the freight cars of the roads affected and both passenger and freight trains were derailed.

On Monday, August 14, 40 green deputy sheriffs surrendered to the mob, and the local militia were called out. Incoming passenger trains were stopped by the strikers and searched, and any suspected of being new workmen were driven away. At Sayre, Penn., on August 15, 50 switchmen struck and the sheriff was resisted in his efforts to protect the movement of trains. On the 16th, the switchmen struck on the New York Central, the Lake Shore, West Shore, B. R. & P., W. N. Y. & P. and Nickel Plate roads. The strike on the New York Central caused only a partial cessation of traffic, but on the other roads freight movement came practically to a standstill. On the 16th and 17th, the police and militia guarded the railroad property at Buffalo and vicinity. During the evening of the 16th, the mob threw stones and missiles at the police and militia but was finally driven off by free use of clubs and bayonets.

The roads easily found enough new men to handle the cars but did not dare to put them to work until assured of ample military protection. They were well supported by the

state and local authorities. On one day 100 men were sent to jail by the Buffalo police court for acts of lawlessness. By Saturday, August 20, there were 8000 of the state militia on the ground. The total number of men on strike at Buffalo was about 650.

The essential grievance of the strikers was that the wages paid at Buffalo while higher than those paid for the same labor elsewhere in the State of New York were less than the "Chicago scale." The Lake Shore and the Nickel Plate paid their men slightly more than the Buffalo rate, but 10 per cent less than the "Chicago scale." On May 20, the legal ten-hour day went into effect; the rate per hour continued the same while the men expected that they would receive the same pay for a ten-hour day that they had received for an eleven-hour day. Frank Sweeney was the leader of the switchmen; his attempt to involve the other brotherhoods in a sympathetic strike failed.

Strike began	August 11.
Acute period ended	August 21.
Strike formally closed about	September 1.

280. *Strike of the Brotherhood of Locomotive Engineers on the Toledo, Ann Arbor & North Michigan Railroad, 1893.* —The newspaper records of the time indicate that the acute period of the strike lasted about four days, but traffic was interrupted more or less for 90 days. The long interruption of traffic was due in part to the boycott of Ann Arbor freight by employees of connecting lines. President Ashley and Chief Arthur agreed to leave the grievance to Kirkby, Railroad Commissioner of the State of Ohio; and Kirkby decided that the strikers should not be taken back into the service except when vacancies should occur. Arthur promptly repudiated the decision, saying that Kirkby had misrepresented the facts. The strike was never formally declared off, the men being discharged and new men hired in their places.

The principal interest in this strike lies not in the acts of the strikers, but in the judicial decisions arising on account of the attempt of the employees of other roads to boy-

cott Ann Arbor freight. Arthur had threatened a boycott and the Ann Arbor road, to be prepared for it, secured from the United States Court at Cleveland, an order enjoining various connecting lines from discriminating against Ann Arbor freight. The order was based on section 3 of the Interstate Commerce Act. Later freight of this road was boycotted by certain employees of the Lake Shore & Michigan Southern Road, at the instigation of Chief Arthur and Chief Sargent. Seven of these men were arrested for contempt of court under the provisions of the law as contained in section 10 of the Interstate Commerce Act; of the men who were arrested, those who had resigned their positions were released, but one employee who had not resigned and had refused to handle this freight while still in the service of the company was fined $50. This was a far-reaching precedent, and excited much discussion at the time. Later an order was entered restraining Chief Arthur and Chief Sargent "from issuing, promulgating or continuing in force any rule or order of any kind . . . which should require an employee to refuse any freight in course of transportation from one state to another" to and from the Ann Arbor; and in case they had already issued such orders, "they and each of them are hereby required and commanded to recall and rescind them."

Strike began	March 8.
Acute period	March 12.
Strike formally closed about	June 8.

281. *Strike on the Lehigh Valley Railroad, 1893.*—The men who entered upon the strike were engineers, firemen, conductors, brakemen and telegraphers; each class belonging to its own brotherhood. The cause assigned by the brotherhoods was that the Lehigh Valley had not kept an agreement made when this road was a part of the Philadelphia and Reading, from which it had meantime been separated. The company stood ready to deal directly with its employees and to listen to any grievance presented, but it declined to receive general committees representing all the various classes in railway service; saying that a locomotive engineer could not

fairly represent the telegraphers, and vice versa. It declined, further, to recognize any labor organization.

The only real grievance appeared to be that the management refused to recognize the brotherhoods in any way. The number of men who entered into the strike was about 2000. On November 18 the classes of employees named above went on strike. As the strike involved all trainmen it was difficult to continue to move trains. Passenger trains were run irregularly, but freight traffic was almost stopped. New men who were employed to take the strikers' places were driven from the work. Several employees were killed while performing their duties.

The boards of arbitration of the States of New York and New Jersey offered their services but they were refused; finally, they submitted a proposition which was adopted; namely, as many of the old employees as should be needed to fill existing vacancies should be taken back into the service without any prejudice on account of their connection with the strike or their membership in any labor organization. The company further agreed to receive committees of employees representing the men in their particular line of service.

The damage done to the property of the road by the strikers was about $77,000; the damage due to loss of traffic was about $500,000. Of the men who went out on strike, it was estimated that about one-half were reëmployed.

Strike began	November 18.
Strike declared off........................	December 6.

282. *Strike of the American Railway Union, 1894* (*The Debs Strike*).—It was estimated that the number of men on strike in Chicago and its immediate vicinity was 8700, the number on strike on roads having their terminals in Chicago was 18,000, and the total number of railroad employees involved throughout the country was 21,000. Of these it is estimated that at least 15,000 permanently lost their places. In all strikes the loss of position falls with greatest severity upon the older men, the firemen and brakemen taking the

places of the engineers and conductors, who permanently lose their employment.

This strike was engineered by the American Railway Union, of which Eugene V. Debs and George W. Howard were the promoters. Debs had attained some political prominence and he had gained some notoriety in the Brotherhood of Locomotive Firemen. Early in 1893, he set about the organization of the American Railway Union. His purpose was to include in the order all branches of railway service throughout the country, and thus create a powerful weapon to coerce the railway corporations; his aspirations were far-reaching and his ultimate object a socialistic government owning and operating all railroads and telegraphs. Having won a victory on the Great Northern Railway, he waited for a favorable moment to launch his plan, and mistook the trouble between the Pullman Company and its employees for a great strategic opportunity. Debs, who had been organizing lodges among the shop employees of the Pullman Company, stepped in and proposed that no Pullman cars should be run on any road in the country until the owners consented to arbitration. He thought he would enlist the sympathy of the public by taking up the cause of these employees and thus conceal the socialistic nature of his "Union." There is a comprehensive article by Ernest Hecht in the July, 1897, *Proceedings of the International Railway Congress* on the dispute between the Pullman Company and its employees.

So long as the public suffers no personal inconvenience from a strike, it is prone to sympathize with the strikers, or at least to be indifferent to the rights of the railway corporations. In this case, however, the inconvenience and suffering incident to stoppage of traffic along the lines of the great common carriers were brought home to thousands of families; this, together with the strikers' absolute disregard of property rights, laid bare the purpose of this labor organization. The results of this strike exercised a salutary influence upon public sentiment and also upon labor organizations for a long time thereafter. In calling out United States troops to prevent interference with interstate commerce, President Cleve-

land gave splendid evidence of devoted courage, and established federal supremacy against disorder, both invaluable precedents.

Strike of switchmen on I. C. R. R.	**June 26.**
Strike became general........................	**June 27.**
First arrival of national troops...............	**July 4.**
Traffic generally resumed....................	**July 9.**
Strike formally declared off by A. R. U.	**August 4.**

It will be noted that two of these strikes—the Martin Irons strike on the Missouri Pacific Railroad in 1886, and the Eugene V. Debs general strike of 1894—were sympathetic strikes to use the control of transportation on one road to force concessions regarding wages or conditions of employment on another road or in a manufacturing industry. Not alone the cost, both in loss of wages to the men and loss of the revenues to the companies, but the disorder and collapse of local government were thrown into high relief; among the results, the organizations became less eager to resort to strikes, the companies sought in every way to avoid them, and the communities sought other means of settling differences. Those most in favor were mediation and conciliation, and where these failed provisions were made for arbitration. On June 1, 1898, Congress passed the "Erdman Act," which was subsequently superseded on July 15, 1913, by the "Newlands Act," providing machinery to further these ends, to be called the "United States Board of Mediation and Conciliation." and to consist of a commissioner and two other officials. Many differences were adjusted through the efforts of the mediators and some arbitrations were conducted, of which the most conspicuous were the following:

Arbitration between Brotherhood of Locomotive Engineers and the eastern railroads, 1912.

Arbitration between Brotherhood of Locomotive Firemen and Enginemen and eastern railroads, 1913-14.

Arbitration between Order of Railway Conductors and Brotherhood of Railroad Trainmen and the eastern railroads, 1914.

Arbitration between Brotherhood of Locomotive Engineers and Brotherhood of Locomotive Firemen and Enginemen and the western railroads, 1915.

Arbitration between the Switchmen's Union of North America and various eastern and western railroads terminating at Chicago, 1916.

Arbitration between the Federated Shop Crafts and 16 railroads in the Southern Territory, 1917.

In March, 1916, a demand was made on all roads of the United States by the Big Four Brotherhoods for an eight-hour day and time and one-half for overtime, and after prolonged negotiations, the efforts of the mediators and conciliators being ineffective, arbitration was offered by the railroad companies and refused by the officers of the brotherhoods. Both sides were sent for by the President of the United States, but notwithstanding the latter's statement that he had spent an hour with Judge Chambers, one of the mediators, going over the schedules and that he clearly understood the situation, he failed to move the executives from their position and went to Congress with a recommendation for the passage of what has since been known as the "Adamson Law."

With this definite breakdown in arbitration, Congress, smarting perhaps at being forced to pass legislation under duress, in enacting the "Transportation Act" of February 28, 1920, placed the whole matter of wages and rules governing conditions of employment in the hands of a "United States Railroad Labor Board," to be appointed by the President with the concurrence of the Senate, where the matter for the time rests.

283. The Grammar of Industry.—How has it come about that we have achieved civilization—"the state of being reclaimed from the rudeness of savage life, and advanced in arts and learning"?

Geologists estimate that mankind has inhabited the earth for a period variously estimated at from one-half million to one million years, and historians discern on monuments, inscriptions and other remains of ancient peoples much evidence of the methods and conditions of life and social organ-

ization running back from the present time for more than five thousand years. Unfortunately, the writers have not developed the art of teaching history in a comprehensive fashion. Much as we know of the past, they have not made the experiences of those who have gone before a sure guide to us. And this is the more to be regretted since next to bread the most urgent need is education.

Nature is indeed a beautiful thing. Consider the glory of a sunset, the sublimity of a mountain range, the soft sweet gentleness of the babe in its crib. What shall we say of nature's ugliness? Consider the maggots writhing in a carcass; lift the fur of a wild animal and see the crawling vermin; think of it, gaunt with famine, or, past its prime, slinking through the rocks until starvation or an enemy ends its existence. Must we endure the sentimentalist, the romanticist, the neurotic, who, seeming to challenge the industrial organization, in the last analysis challenge creation? Can we not concern ourselves with doing the best we can with the means that are given us wherewith to do in this world into which we are born?

It is disconcerting to realize how little security we have won for ourselves by our age-long struggle with nature. From the vegetable kingdom we have brought into cultivation some 212 systems of plant life; from the animal kingdom into a state of domestication some 49 types, of which 42 serve as food sources; from the mineral kingdom, of the 83 known elements, about 61 have been brought into serviceable use; and of the 92 possible chemical elements, five remain to be discovered.

The average daily consumption of food necessary to support human life is a total of 3400 grams; in proportion of protein, 100 grams; fat, 100 grams; carbohydrates, 500 grams. With our habit of overeating we consume per adult man a daily average of 4,288 grams. Besides these constituents, the food contains mineral salts and vitamines, the latter food accessories that have not as yet been identified but are thought to be essential to health and growth.

Of the food consumed, only 29 per cent is net nutriment;

the remainder is water, ash and inedible refuse, so that we need for our entire population more than 99,000,000 tons of food-stuffs annually. The main sources of supply, cows, pigs and wheat, provide 65 per cent of all calories. While no possible source can be neglected, the increases of the future will be most surely obtained by concentrating on these great staples. Fortunately, for the time being, the food supplies of the United States are increasing more rapidly than the population.

We now have a population of more than 105,000,000. Our people made their first settlement here 300 years ago. It was estimated in the industrial census of 1912 that the accumulated wealth of the country, including land values, was $187,000,000,000, probably substantially impaired in the mad orgy of the war, and this is but little more than we are able to produce in the space of five years. Nor has this wealth any great permanence. A study of property with the appearance of permanence seen in the railroad, and based on the tentative valuations of 55 railroads now reported by the Interstate Commerce Commission, indicates a "weighted life" of no more than 20 years, so that it is probably true that each generation, in providing for the next, must twice replace the great bulk of its wealth, as well as make the additions thereto necessary for advancing comfort and security and essential to the provision of employment for increasing numbers.

And this last is an element the magnitude of which must not be underestimated. As shown in 1912, before an additional man can be employed, his employment is conditioned upon a capital saving and investment of: $2700 for the farm laborer, $2500 for the industrial worker, $8500 for the railroad employee.

During the Napoleonic wars the white race numbered about 100,000,000 souls and was increasing at the rate of five per cent each decade; during the World War it numbered more than 500,000,000 souls and was increasing at the rate of 15 per cent each decade. And this was not at all from an increase in the birth rate but from conservation of

life by police, medicine and surgery, and even more by vast increases in productivity.

The effect of this is to increase further the proportion and number of those coming into employment, and if they are not to compete for opportunity for work to the dispossession of the older and less fit among those already employed, and to the breaking down of the wage scale, new and additional opportunities must be made for them, and this is a situation that must be reckoned with by the workmen for their own preservation.

Man has found only four ways of organizing for production and these may be seen still in practice in various parts of the earth.

He organized as a hunter, and it took about five and a half square miles of land to support him. He organized as a herdsman and it took about one square mile of land to support him. He organized as a farmer, depending on his hand labor, almost without tools, and about three persons could be supported on one square mile of land. He organized in what is described as an "industrial civilization" and now in Massachusetts we are supporting 407 people to the square mile of land, assembling from the vicinage and from distant areas their means of support.

We could not support in this country under any organization that has ever been tried or given any promise of success other than the industrial organization, more than a fraction of our present population, unless they lived in the stark poverty of the Chinese, dependent upon a farming occupation, conducted with a few rude tools, reduced to hand labor and subsisting on a vegetable diet.

The activities of man in connection with material, after it has been brought into the "raw" state, that is, after it has been harvested, lumbered or mined, divide along two main streams. The composition and shape of the "raw" material is changed, as when metallic iron is extracted from the ore and formed into pigs or billets, and as when, from the trunk of a tree, wood is sawed, turned, carved and assembled into a chair. The location of material "raw" or fabricated

is changed by collection, transportation and distribution, as by the railroads, merchandising, etc.

These activities may be carried on by individuals, partnerships, corporations and other forms of association, and may be pursued in the narrow sense of one change only, or they may cover the whole range of changes, as from mining to marketing.

The industrial organization by which these processes are effected is organized, energized and directed by management. The enterpriser conceives a plan. The conception is basic, fundamental. He makes the necessary investigation of the field to be covered, the means essential for its execution. Unfortunately, there is a dearth in the highly specialized skill which results in prosperous business, not enough of it existing to keep all industry in a high state of efficiency; nor is it a quality that is developed by government organization or by ordinary education. For to specialized skill must be added knowledge of men and affairs, political sense, an extraordinary perspicuity and self-effacement, those qualities that make the possessors of them towers of strength and resource.

The enterpriser in his organization of industry uses in its service the two instrumentalities of capital and labor.

There is a wide distinction to be drawn between the laborer, a human being, and labor used as a verb to denote an emanation of force—the product of a heat machine, the human body. Nor is the energy generated by the human heat machine of any considerable amount. Labor may indeed be associated with intelligence; the conscious application of the mind, in every move of some industrial processes; while in others the action of the mind is largely limited to the coördination of the muscular and bony systems, the articulating parts of the body, rather than to any participation in the work itself. The phrase "labor-saving machinery" is not a misnomer. The energy furnished by the human heat machine is in this case furnished by the expansive force of steam, the coördination effected in the parts of the human body by the mind is effected by combinations of belting, pulleys, levers,

screws, wedges, cranes, wheels, electric dynamos and apparatus, etc., etc.

Observations by Sir William Ramsay, experiments with men walking on a moving platform, or pumping water, calculations of the efficiency result of the intake of food, the relation of heat to power, all indicate in a well-conditioned muscular man an energy output of four one-hundredths of a horsepower.

A prominent engineer who has had much service in the West is fond of recalling, as an example of high activity, that in April, 1915, he, then weighing 175 pounds, walked from the water's edge of the Colorado River, three miles, to the Indian Village in the Grand Canyon, making the ascent of 2600 feet in 82 minutes. His energy output was .17 of a horsepower.

In May, 1920, Howard Broome, a well-conditioned athlete of great physical ability, weighing 215 pounds, ran from the sub-cellar to the cupola on the top of the Equitable Building, 120 Broadway, New York, a height of 599 feet, in eight minutes 52 seconds, producing energy during that time at the rate of .44 of a horse-power.

Relating these examples to what is known of industrial occupation, much of which is more of the character of watching and tending than of the use of generative energy, it would seem as though one-hundredth of a horse-power is a liberal estimate of the eight-hour work capacity of the human machine. So feeble is the energy output of man that he has only been able to raise himself from a state of nature by providing himself with tools, and of far greater significance, with other sources of power.

The instrument of capital has been known to us since the earliest times as a form of private property. Three thousand five hundred years ago, Abraham took his wife, Sarah, and Lot, the son of his brother, and the substance that they had gathered unto themselves and the souls that they had gotten in Haran and went forth to go down into the land of Canaan. The story goes on to say that Abraham was very rich in cattle, in silver, and in gold, and you get a good

picture of the nomadic, pastoral life, and of the city life in Sodom and Gomorrah, and you find there a civilization which can be traced back through the five or six thousand years in which we grope through history. That civilization depends upon three prime factors—the institution of the family, the right in private property, and a settled social order based on justice and morality.

Capital is originally that product of labor and intelligence which, instead of being dissipated currently as produced, is saved and used either by the saver or by him put to the service of others, he looking for recompense for his self-sacrifice and abstinence to a satisfactory reward in rents, interest or dividends.

There is no difference between the dollar earned and spent and the dollar earned and saved, except that the latter has added to it certain very significant virtues, the virtues of abstinence, self-denial, foresight, and of being put to the service of others. There is no difference between the dollar earned and saved and held in the possession of the man who earned it, and the dollar earned and saved and passed on to heirs. Anyone who can appreciate, in the great industries like the railroads, the difference between a floating debt and a funded debt, will recognize the difference between money that is simply held temporarily by its owner, and money so placed by the owner that it may continue in service, passed on through inheritance. The right in private property and the right to dispose of it after death lies at the root of our civilization and are the most powerful incentives we know to the production and conservation of wealth.

The accumulation of wealth is a very slow process and the benefits flowing to the laborer from its saving by the owner and from its use by the enterpriser are but little appreciated. It is because of the superlative productivity of capital that so many of us are able to live in the industrial organization. It is of the most vital importance to the laborer himself that capital shall grow as rapidly as possible, and be made as significant as possible in the industrial relation; and no more dreadful harm could be done to the workman than to do

things that prevent the accumulation of capital or prevent its employment in the industrial organization.

In this vast activity, what are the relative contributions and what are the relative rewards of the associates? The literature of the day is filled with discussions as to the "distribution of the product"; almost nothing is ever said as to the "contributing effort." I am not aware of any considerable or well considered body of information regarding the relative contributions to value by the brainworkers, the property owners and the hand workers.

The business is organized, energized and directed by management. As to the reward paid management, it can only be said that no more fatal economy could be made than to curtail the application of brains to industry, and it would be a very dangerous experiment to make any great reduction in their remuneration. Nor is it likely that the administration and clerical staff is redundant or that many could be eliminated without reduction of output.

Sir Hugh Bell states that "75 per cent of the total value of the commodities produced will have gone to pay the persons engaged in producing them."

Extremists among the labor leaders claim that the laborer produces it all. If we attach any significance to the words we use, this is manifestly impossible. Nor may we be unmindful of the rapidly changing conditions. For example, such have been the improvements in wheat growing that the employment of the laborer has been reduced from 164 minutes per bushel in 1840 to 36 minutes per bushel in 1920; that is, the contribution made by the laborer in his labor is only twenty-three per cent of what it was eighty years ago.

Extremists among the employers claim that in many industries the laborer has become parasitic—not putting in through his help as much as he takes out in his wage; the balance of the help—the contribution of management and capital—having become relatively so large. If this be true, then the demand that the laborer be rewarded in proportion to his contribution to production is unworkable. For on any such basis he could not sustain life.

Neither of these views gives consideration to the fact that a significant proportion of the workmen bring to their work intelligence ranking from good to high, fine character, real courage and steadfastness, giving poise to the mass and furnishing to management recruits for essential leadership. On the one side these men have been the victims of the Trades Unions which, as Tannenbaum states, "work by cumulatively reducing economic incomes, economic ambitions and economic incentives to a common denominator, wiping out the differentials between the unskilled and the skilled," and on the other side these men have been measureably neglected by management, which has failed to provide adequate instruction and a proper measure of interest and consideration. We should work out a system of compensation reflecting the range of intelligence, character, and skill, which differentiates one man from another.

The rewards of capital are often much overstated. Significance must be given to the difference between income and spendable income. Out of the income of capital must be set aside the sum necessary to make good the years' destruction of capital, including the wasting assets spoken of as depreciation, the savings necessary for progress and the provision of plant to provide work for the increase of the industrial population; a contribution to the expenses of government, federal, state, county, city, etc., and these allotments absorb a very substantial part of the whole. Further, much of the profit never comes into the hands of the individual owner, as the investment of earnings by successful organizations in their own business is one of the main sources of industrial progress. A large part of the profits arises from professions and occupations to the production of which wage-earners contribute very little, and another part is due to special skill of management, and to partial monopoly, the excess of whose profits is not due to the workers who helped to make them. The contributions ascribed to management and capital are not to be taken as furnished solely by the enterpriser and capitalist of to-day, but owe much of their potency to the accumulated achievement of science and invention during many

generations, themselves the achievements of the enterpriser and capitalist.

Capital for all its strength is characterized by extreme timidity and looks for its defence to its agility and fleetness in running, but that it has ample capacity to take care of itself a long history makes clear.

Like the arguments in the fable as to the relative value of the several parts of the body, the hands, mouth, heart, etc., from some standpoints these considerations are negligible. The fact is that all three elements: management, capital and labor are essentially necessary, that the relation is a voluntary association, and that it can be induced and maintained only upon terms that are satisfactory to each.

The number of men having the ideas, the "look-ahead," the specialized skill necessary to create or keep industry in prosperous condition, is exceedingly limited. Their ability to secure capital is much simplified by the machinery organized for its handling and by its tendency to content itself with a uniform rate of reward much as water seeks a level.

Not so simple is the securing of labor. No satisfactory methods have been instituted by management, while the organizations created by the workman are obstructions rather than aids, since they have many interests to which they attach greater value.

While the foregoing considerations may not help in determining the basis for wages further than to clear away obstacles, what they do make clear is the extent to which it is to the interest of the workmen that the volume of capital and the efficiency of management should steadily and greatly increase.

It is not feasible to raise the level of wages by raising the level of prices. If prices are increased in one industry only, it is at the expense of the others; if the rise spreads to all industries it benefits no one, while during the considerable period necessary for the adjustment there are great hardships.

The return to capital may be brought too low by taxation, or its possession rendered uncertain by alteration in

the laws of inheritance, by the plundering of estates through death duties or by confiscation. The upkeep and development of the organization and plant necessary for future production may be sacrificed, as to some extent they were during the war. But these as methods of raising wages are suicidal.

The temporary raising of wages by labor union pressure is shortly reflected in unemployment. Employment by the state holds forth no promise, since the state has no power or recourse not possessed in much greater measure by competitive employers. If the enterpriser is abolished it is only to bring the worker face to face with his real employer, the consumer. It is not to be supposed that the whole of the consumers, whose interests are certainly not on the side of costly concessions, will allow industry to be manipulated against themselves. It is probable that when we get the whole picture of what has been going on in Russia under Lenin and Trotsky, there will be found very little that is attractive in the suggestion of nationalization. Under their socialistic régime every incentive that promoted prosperity or lessened adversity in other countries has been obliterated. The individual's personal interest in the fruits of his own endeavors has been wiped out; that whole play of motive and calculation, of social organization and individual ambition, on which the economic activities of the world have rested for thousands of years has been brought to an end. In its place has been substituted an organization of society spun out of the brains of a group of fanatics, and put into operation without regard to the teachings of experience. After three years' trial of this system, in a country of boundless resources, there is reported a state of destitution without parallel in the history of the world.

There remains the one hopeful way—by increasing production. The possibilities of the future should be at least as great as those of the past. The skill of management may be increased, its field of activity extended, its control strengthened. Capital can be better applied, its accumulation encouraged, its integrity assured. Labor must not

waste its productive power, nor limit the maximum use of plant and machinery. Greater encouragement of skill, more facilities for promotion from unskilled work to skilled, better education, together with full opportunity for the use of all intelligence, knowledge and strength, irrespective of sex in tasks not disproportionate to woman's strength, and without insistence on outworn rules as to previous training, will promote the fuller use of the latent abilities of the race.

These improvements are indicated, not accomplished; they require time, ability and patience. Any attempt to grasp the fruits of progress before the tree that might produce them is cultivated, can only result in disappointment and failure.

The wealth of the country, more evenly divided here than in any other part of the world, was not sufficient before the war for a higher standard of living than then obtained.

If the rewards of the future are to be increased, the most important task, incumbent upon employers and employes alike, is to increase the national product.

Think on a man like Nelson. His presence was victory; he had been in a hundred fights and bore their scars. One arm off, one eye out, his scalp torn off at the Nile, his frail body racked with the agonizing pains of tic douloureux, he yet held on until at Trafalgar, he assured the safety of the British Empire for a hundred years. Think on the simple entry in the log of his flagship: "Partial firing continued until 4:30 p.m., when, a victory having been reported to Admiral Lord Viscount Nelson, K. B., and Commander-in-Chief, he THEN *died of his wound."*

But as when the sun approaches the gates of morning, he first opens a little eye of heaven, and sends away the spirit of darkness, and gives light to a cock, and calls up the lark to matins, and by and by gilds the fringes of a cloud, and peeps over the eastern hills, thrusting out his golden horns, like those which decked the brow of Moses when he was forced to wear a veil, because he himself had seen the face of God; and still while a man tells the story, the sun gets up higher, till he shows a fair face and a full light and then he shines one whole day, under a cloud often, and sometimes weeping great and little showers, and sets quickly; so is a man's reason and his life.

JEREMY TAYLOR

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